
TECHNICAL GUIDANCE MANUAL

for

the Implementation of

The Hawaii State Contingency Plan

**State of Hawaii
Department of Health
Hazard Evaluation & Emergency Response**

**919 Ala Moana Boulevard, Rm 206
Honolulu, Hawaii 96814**

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This document was prepared by the Hawaii Department of Health Hazard Evaluation and Emergency Response Office with the assistance of Superfund Program information from the State of New Jersey, the State of California, the State of Wisconsin, and the United States Environmental Protection Agency.

Use of this Document

This TGM is intended to be used as guidance to the owners, operators of contaminated property and their contractors who are complying with the terms of Chapter 128D and Title 451, the State of Hawaii Superfund Program. The purpose of this program is to respond to releases (past and present) of hazardous substances, including oil.

Oil is defined as crude oil and any fraction or residue thereof, in any form, but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes. Oil is designated as a hazardous substance in Chapter 128D, Hawaii Environmental Response Law (HERL).

Disclaimers

The Hawaii Department of Health hereby gives notice to all interested parties that the information in this guidance manual is for informational purposes only. Nothing contained in this guidance manual relieves any person from the responsibility of complying with the rules and regulations on Environmental Response or any other applicable Federal, State, and local government requirements.

Mention of trade names or commercial products in this manual is not to be construed as an endorsement or recommendation by the Hawaii Department of Health.

Consistency with other DOH Guidance

The HEER Office has made every attempt, wherever possible, to maintain technical consistency with all other DOH programs in the State of Hawaii, especially the UST Program.

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Glossary

| | |
|--------|--|
| ACS | Aquifer Classification System |
| AOAC | Association of Official Analytical Chemists |
| AOC | Area of Concern |
| APHA | American Public Health Association |
| ARs | Applicable Requirements |
| ASTM | American Society for Testing and Materials |
| AWWA | American Water Works Association |
| BDAT | Best Demonstrated Available Treatments |
| BTEX | Benzene, Toluene, Ethylbenzene, Xylene |
| CA | Consent Agreement |
| CERCLA | Comprehensive Environmental Response, Compensation & Liability Act |
| CLP | Contract Lab Program |
| DE | Decontamination Equipment |
| DO | Dissolved Oxygen |
| DOH | Department of Health |
| DPT | Direct Push Technology |
| DQA | Data Quality Assessment |
| DQOs | Data Quality Objectives |
| EPA | Environmental Protection Agency |
| EPCRA | Emergency Planning and Community Right-to-Know Act |

| | |
|-------|--|
| FS | Feasibility Study |
| FSP | Field Sampling Plan |
| GC | Gas Chromatography |
| HEER | Hazard Evaluation and Emergency Response |
| HERL | Hawaii Environmental Response Law |
| HSP | Health and Safety Plan |
| HUD | Housing and Urban Development |
| IDW | Investigation Derived Waste |
| LEPC | Local Emergency Planning Committee |
| MS | Mass Spectrometry |
| NCP | National Oil and Hazardous Substances Contingency Plan |
| ND | Non Detect |
| NFA | No Further Action |
| NIOSH | National Institute for Occupational Safety and Health |
| NOAA | National Oceanic and Atmospheric Administration |
| NPL | National Priorities List |
| NRC | National Response Center |
| O&M | Operation and Maintenance |
| OSHA | Occupational Safety and Health Administration |
| OSWM | Office of Solid Waste Management |
| PAH | Polynuclear Aromatic Hydrocarbons |
| PAL | Preliminary Action Level |

| | |
|------|--|
| PCB | Polychlorinated Biphenyls |
| PCP | Pentachlorophenol |
| PE | Performance Evaluation |
| PPE | Personal Protection Equipment |
| PRG | Preliminary Remediation Goal |
| PRP | Potentially Responsible Party |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| RAM | Response Action Memorandum |
| RAR | Removal Action Report |
| RCRA | Resource Conservation and Recovery Act |
| REPR | Real Estate Planning Report |
| RI | Remedial Investigation |
| RQ | Reportable Quantities |
| SAP | Sample and Analysis Plan |
| SCP | State Contingency Plan |
| SDT | Site Decision Team |
| SOSC | State On Scene Coordinator |
| SVOC | Semi-volatile Compound |
| TAL | Target Analyte List |
| TBC | To Be Considered |

| | |
|---------------|---|
| TCL | Target Compound List |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TDS | Total Dissolved Solids |
| TGM | Technical Guidance Manual |
| TOC | Total Organic Carbon |
| TPH | Total Petroleum Hydrocarbons |
| USATHMA | United States Army Toxic & Hazardous Materials Agency |
| UST | Underground Storage Tank |
| UTL | Upper Tolerance Limit |
| VOC | Volatile Organic Compound |
| WRRC | Water Resources Research Center |
| XRF | X-Ray Fluorescence |

Section 1

INTRODUCTION

Section 1

INTRODUCTION

1.1 Purpose

The purpose of this manual is to provide procedural and technical guidance to potentially responsible parties (PRPs) and to Department of Health (DOH), Hazard Evaluation and Emergency Response (HEER) Office personnel to address hazardous substance releases in Hawaii in accordance with Chapter 128D, The Hawaii Environmental Response Law (HERL) and Title 11, Chapter 451, State Contingency Plan (SCP).

This manual is organized in a manner which will provide step-by-step guidance throughout the response process. Please refer to Figure 1-1 for an overview of the response process. The manual describes the approach to be taken for both removal and remedial response actions. Although the process is similar for addressing all hazardous substance releases, both the characteristics of the release and the potential receptors will determine the scope of the response and whether removal or remedial authorities will be used. It is intended that the scope of the response action will be commensurate with the relative magnitude and complexity of the problem being addressed. The HEER Office anticipates that the majority of sites will be addressed through the removal process, with fewer sites requiring the full complexity of the remedial investigation and feasibility study process followed in the national Superfund program.

1.2 Background

Within the Department of Health, the Hazard Evaluation and Emergency Response Office is charged with implementing the statutory requirements of Chapter 128D, Hawaii Environmental Response Law. The Department of Health is mandated to protect human health and the environment from the actual or potential release of hazardous substances. In 1988, the State of Hawaii passed Act 148 (148-88) which established Chapter 128D, Hawaii Revised Statutes, Environmental Emergency Response. The Act established an environmental emergency response revolving fund and authorized DOH to perform emergency removal actions of hazardous substances, require responsible parties to perform necessary removal or remedial action, recover costs incurred by DOH in the course of performing any necessary actions, and develop a contingency plan for the cleanup of hazardous substance sites in the State.

Chapter 128D is modeled after the federal Comprehensive Environmental Response,

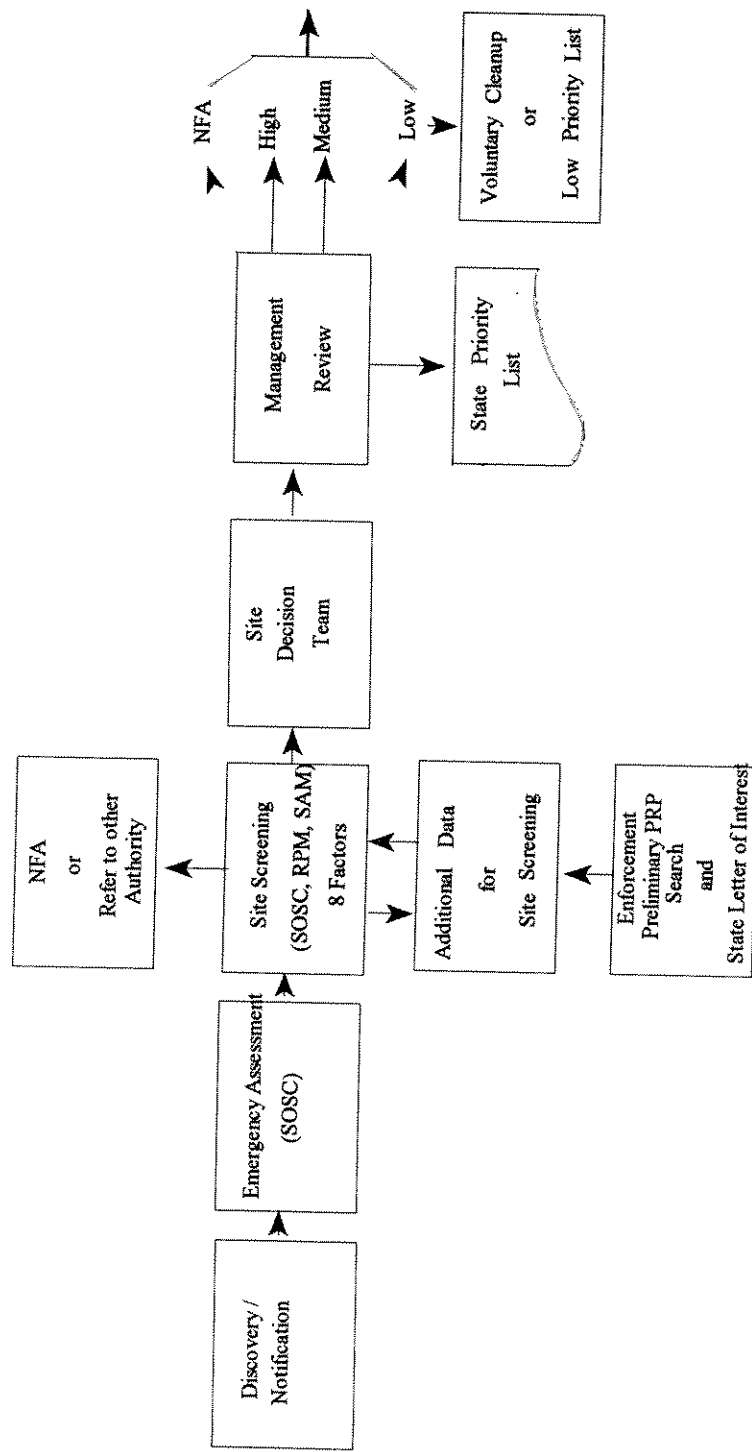


Figure 1-1a Overview of Response Process

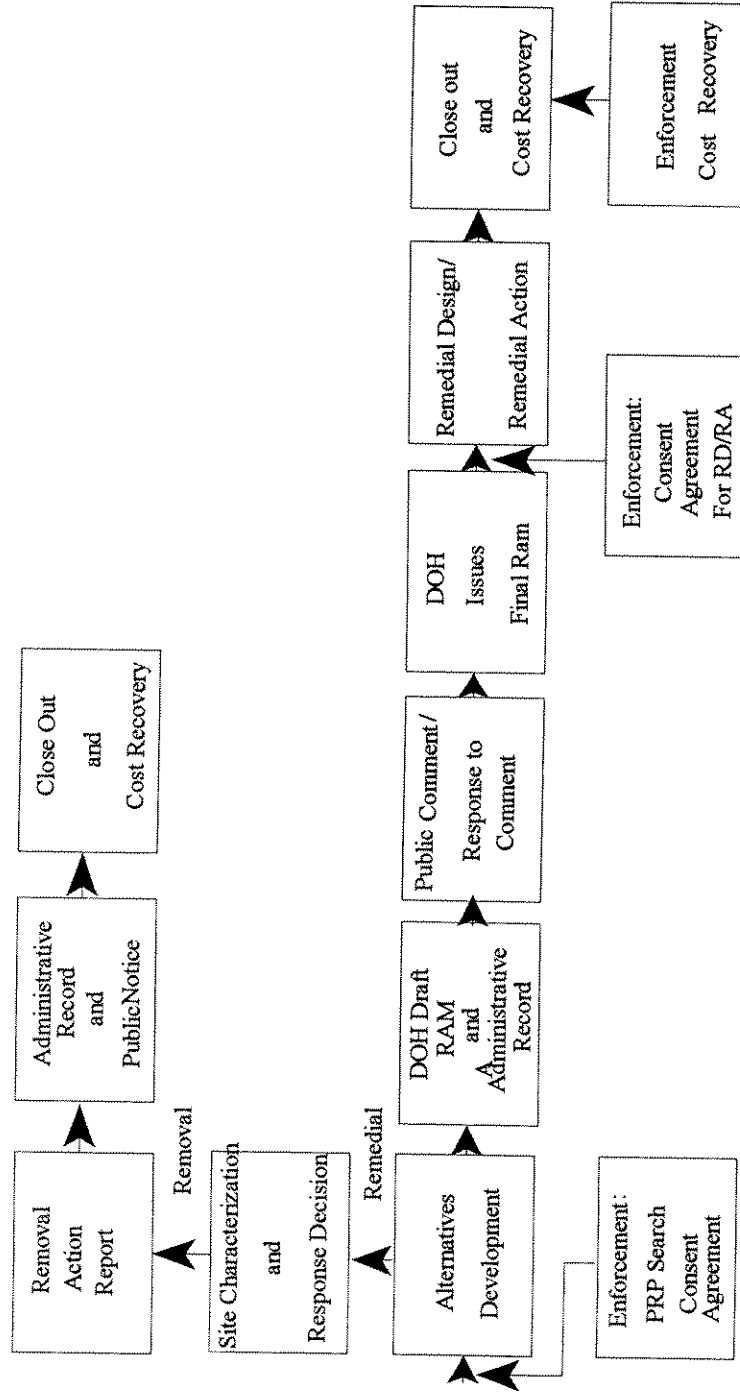


Figure 1-1b Overview of Response Process

Compensation and Liability Act (CERCLA). The general liability provisions and the response process are similar. The primary difference between the State and federal legislation is that the State defines hazardous substances to include oil, which includes gasoline, diesel fuels, and crude oils. Also, as mentioned earlier, the HEER Office anticipates that the majority of sites will be addressed through the removal process rather than the more complex and time consuming remedial process.

Act 298-90 (which established Chapter 243) substantially amended Chapter 128D, HRS, by adding various new sections, amending the existing sections, and changing the title to the Environmental Response Law. The change in the title reflects the fact that the amended law broadened the scope of DOH's authority to include long-term environmental and health threats. The Act gave DOH the additional authority to conduct and fund both removal and remedial actions.

In 1993, Act 300 amended Chapters 243 and 128D. Chapter 243 was amended to include a five cent per barrel tax on petroleum. The proceeds of this tax are placed into the Environmental Response Revolving Fund (the Fund). The proceeds of the tax may be used for:

1. Oil spill planning, prevention, preparedness, education, research, training, removal and remediation;
2. Direct support for county used oil recycling programs; and
3. Addressing concerns related to underground storage tanks, including support for the underground storage tank program and funding for the acquisition by the State of a soil remediation site and facility.

Non-petroleum related releases may be addressed using funds deposited in the Fund from other sources, including DOH compliance proceedings.

1.3 Legal Authorities

1.3.1 DOH Authority

Section 128D-4 provides DOH with the authority to address hazardous substance releases which may present a substantial danger to public health, welfare, or the environment. Specifically, DOH is authorized to conduct a response action:

1. whenever there is a hazardous substance release; or
2. there is substantial threat of a hazardous substance release; or

3. there is a release or substantial threat of such a release of any pollutant or contaminant that may present a substantial danger to public health, welfare, or the environment.

When the aforementioned conditions exist, the HEER Office is authorized to conduct a removal or remedial action or take any other response measure consistent with the State Contingency Plan which the Director deems necessary to protect the public health or welfare or the environment. The DOH may, in accordance with §128D-4:

1. Issue an administrative order or take any other enforcement action necessary to compel any known responsible party or parties to take appropriate removal or remedial action necessary to protect public health and safety and the environment;
2. Upon determining that there may be an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance, issue without a hearing, such orders as may be necessary to protect the public health, welfare, and the environment;
3. Solicit the cooperation of responsible parties prior to issuing an order to encourage voluntary cleanup efforts; and, if necessary, negotiate enforcement agreements with responsible parties to conduct needed response actions according to deadlines established in compliance orders or settlement agreements;
4. Undertake those investigations, monitoring, surveys, testing, sampling and other information gathering necessary to identify the existence, source, nature, and extent of the hazardous substances or pollutants or contaminants involved and the extent of danger to the public health or welfare or to the environment;
5. Perform any necessary removal or remedial actions so as to abate any immediate danger to the public health or welfare or to the environment; and
6. Contract the services of appropriate organizations to perform the actions set forth in paragraphs (1), (2), (3), (4), and (5).

1.3.2 Liability

Liability under Chapter 128D is strict, joint and several liability. Strict liability is considered legal responsibility which is assessed without regard to fault. Joint and severable liability refers to the concept that each entity involved could be individually liable for the entire cost.

The liability provisions are outlined in section 128D-6. With a few exceptions, which are discussed later, the following parties are potentially liable under Chapter 128D:

1. The owner or operator or both of a facility or vessel;
2. Any person who at the time of disposal of any hazardous substance owned or operated any facility at which such hazardous substances were disposed of;
3. Any person who by contract, agreement, or otherwise arranged for disposal or treatment, or arranged with a transporter for transport for disposal or treatment, of hazardous substances owned or possessed by such person, by any other party or entity, at any facility or on any vessel owned or operated by another party or entity and containing such hazardous substances; and
4. Any person who accepts or accepted any hazardous substances for transport to disposal or treatment facilities or sites selected by such person, from which there is a release, or a threatened release, which causes the incurrence of response costs of a hazardous substance.

In general, potentially liable parties include the present owner and operator; the past owner and operator at the time of the release; any person who arranged for the disposal of a hazardous substance; and any person who accepts hazardous substances.

Any person liable under Chapter 128D is liable for:

1. All costs of removal or remedial actions incurred by the State or any other persons to the extent such costs and actions are consistent with this Chapter, the State Contingency Plan, and any other State rules;
2. Damages for injury to, destruction of, or loss of natural resources, including the reasonable costs of assessing such injury, destruction, or loss resulting from such release; and
3. The cost of any health assessment or health effects study carried out consistent with this Chapter, the State Contingency Plan, or any other State rules.

Exemptions from liability are provided in subsections 128D-6(c) and (d). Subsection 128D-6(c) exemptions are applicable when the hazardous substance release was caused by an unanticipated natural disaster, an act of war, or an act or omission by an unrelated third party. The exemption under subsection (d) is an "innocent landowner" provision. This exemption may be established if at the time of acquisition, a defendant

made all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice in an effort to minimize liability.

1.3.3 Cost Recovery

DOH is authorized under Section 128D-4(c) and Section 128D-5 to recover costs from potentially responsible parties expended by the State for removal or remedial actions conducted by the State, the State's share of federal removal or remedial actions, and costs incurred by the State in the restoration, rehabilitation, or replacement or acquisition of any natural resources injured, destroyed, or lost as a result of a release.

If the HEER Office conducts the response action at a site where a PRP has been issued an order but does not comply, the PRP may be liable to the State for punitive damages of up to three times the amount of any costs incurred by the fund (128D-8).

Private party response actions are also eligible for cost recovery against other liable parties. However, in accordance with Section 128D-6(j), no person other than a government entity may recover costs or damages arising from a release which occurred before July 1, 1990.

1.4 General Response Process

The response process outlined in this guidance document is designed to allow for varying degrees of oversight from the HEER Office for potentially responsible parties who are conducting response actions. The preferred approach for the HEER Office is to enter into consent agreements with PRPs outlining the response actions to be conducted by the PRP. It is intended that through a cooperative approach the facility in question can be remediated in a more efficient manner. The HEER Office should be involved prior to any extensive field investigation in order to avoid potential costly and inefficient duplication of effort.

When PRPs and the HEER Office fail to enter into consent agreements, the HEER Office reserves the right to order a response action or to conduct such actions using the Fund.

1.4.1 Notification and Discovery

The HEER Office may become aware of a release of a hazardous substance either through required notification or through discovery. Notification to the HEER Office, the Local Emergency Planning Committees (LEPC) and the National Response Center (NRC) is required if a hazardous substance has been released to the environment in an amount equal to or greater than its reportable quantity (RQ). In addition, through the HEER Office's site discovery program, facilities at which a release or threat of release

has occurred may be identified. The HEER Office may pursue a response action at a facility where a release is less than the RQ if identified through other forms of discovery.

1.4.1.1 Notification

Chapter 128D authorizes DOH to identify hazardous substances and to establish a corresponding reportable quantity. Chapter 11-451, SCP has established hazardous substances as:

- substances identified in 40 CFR Part 302, table 302.4;
- substances identified in 40 CFR Part 355, Appendixes A and B;
- Unlisted Hazardous Substances as defined in 11-451-5;
- trichloropropane; and
- oil.

The reportable quantity for the specific hazardous substance is also listed in the tables or appendices noted above. For trichloropropane the RQ is 10 pounds. The RQ for oil is as follows:

1. Any amount of oil which when released into the environment causes a sheen to appear on surface water, or any navigable water of the State;
2. Any free product appears on groundwater;
3. Any amount of oil released to the environment greater than 25 gallons;
4. Any amount of oil released to the environment which is less than 25 gallons, but which cannot be contained and remedied within 72 hours; or
5. Any amount of oil released to the environment which may cause an imminent and substantial endangerment to public health or welfare or the environment or natural resources.

1.4.1.2 Discovery

The HEER Office maintains an active program to identify facilities where there has been a release of a hazardous substance, pollutant, or contaminant into the environment. The HEER Office may be notified of such a facility through public

complaint, anonymous tips, field observation, inspections, the site discovery program or a number of other ways. Once the HEER Office has determined that a release has occurred at a facility, the HEER Office may conduct a response action or may order a PRP to conduct a response action.

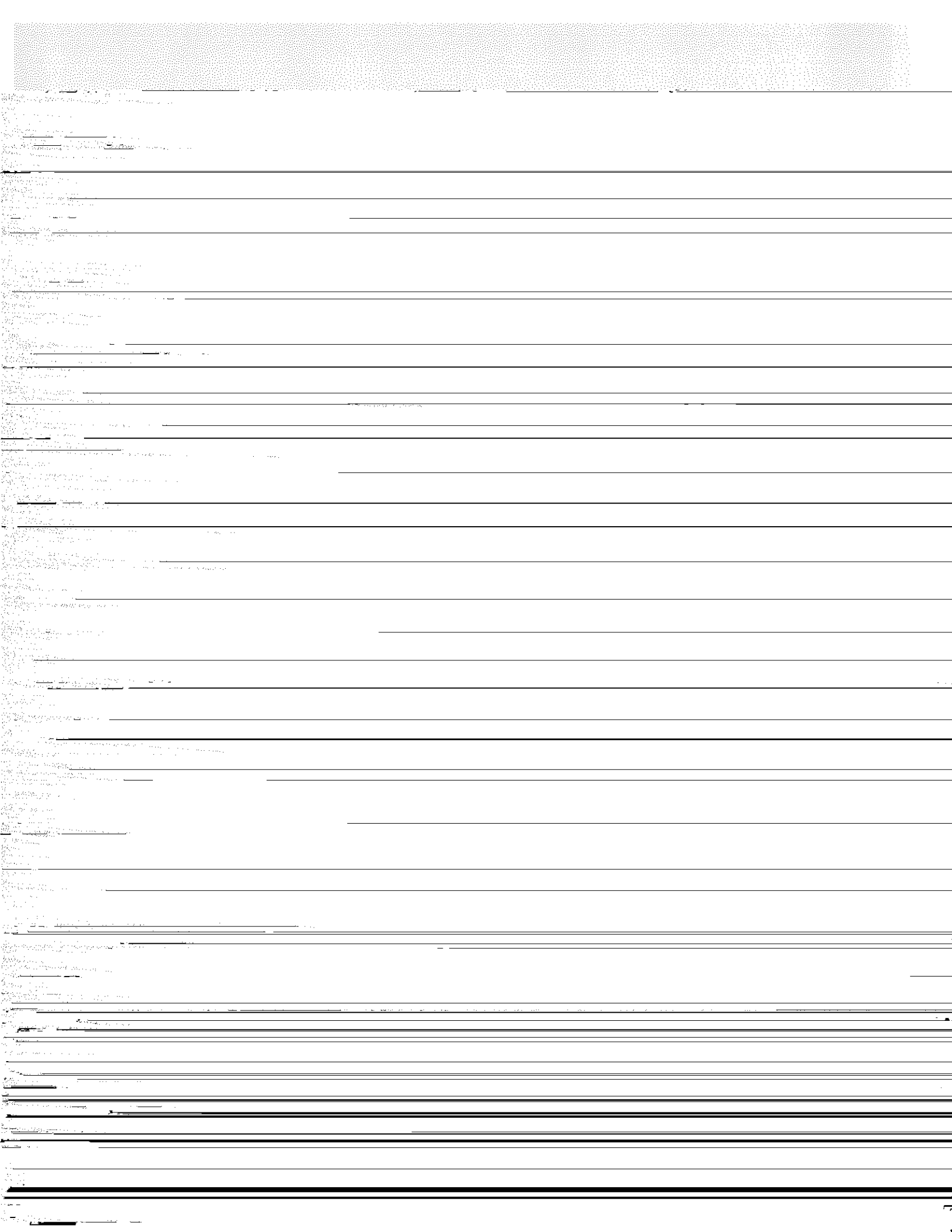
1.4.2 Site Screening and Listing

Pursuant to Subchapter 128D-7, HRS, DOH will publish a list of sites subject to the Chapter 128D. The sites to be placed on the list shall include:

1. Sites at which the potentially responsible party is in compliance with an order issued by DOH;
2. Sites that have not been adequately characterized and at which the potentially responsible party is not in compliance with an order issued by DOH; and
3. Sites that have not been adequately characterized and DOH has not been able to identify a responsible party.

The HEER Office has established a Site Decision Team (SDT) to prioritize those sites which will be listed. The SDT will assess the potential for listing a site by utilizing the following criteria:

1. Actual or probable release to ground water which is a drinking water supply;
2. Actual or probable release to surface water which is a drinking water supply;
3. Actual or probable release to air that poses a threat to public health;
4. Actual or probable release to and extensive contamination of soil that poses a direct contact hazard due to uncontrolled facility access;
5. Actual or probable existence of uncontrolled hazardous substances or pollutants or contaminants, such as leaking containers or impoundments, that pose a direct contact hazard due to uncontrolled facility access;
6. Actual or probable adverse impact to natural resources;
7. Actual or probable imminent danger of fire or explosion; or
8. that the facility or vessel presents a substantial danger to public health or welfare or the environment or natural resources.



1. The immediacy of the threat;
2. Planning time;
3. Implementation time;
4. The degree of risk to public health or welfare or the environment or natural resources;
5. Cost;
6. Community interest;
7. Site complexity;
8. The availability of other appropriate response mechanisms; and
9. Other situations which may pose imminent and substantial threat to human health and the environment.

In general, site complexity will be the primary factor, although other considerations could place a site on the remedial path.

Removal

Neither the Environmental Response Law nor the State Contingency Plan, places a monetary limit or planning time limit on removal actions (as does the NCP). Therefore, site conditions and the degree of public interest will influence the use of removal or remedial authorities.

Emergency Removal

An emergency situation exists if there is a release, or threat of a release, of a hazardous substance which may pose an imminent and substantial danger to human health and the environment. The HEER Office or the County Fire Department will determine if an emergency situation exists. Once the situation is stabilized, the County will transfer command to the HEER Office for cleanup and oversight. Coordination of the response will be in accordance with the State of Hawaii Oil and Hazardous Substances Emergency Response Plan.

Upon stabilizing the emergency or upon making a determination that an emergency does not exist, but a hazardous substance release has occurred, the HEER Office will

issue a "Letter of Interest" (LOI) to the PRP(s).

If hazardous substances remain on site, the HEER Office will assess the site for potential listing. If emergency response activities have addressed the entire release or threat of release of hazardous substances at the facility, then the HEER Office will not list the facility.

Following the emergency removal, the PRP will complete a Removal Action Report (RAR). If the HEER Office conducts the response and uses more than \$25,000 of fund money, then the HEER Office will complete a RAR and publish a public notice of the availability of the RAR. For more information on RARs, see Section 5.

Non-Emergency Removal

For non-emergency removals, the PRP will complete a Removal Action Report (RAR) which discusses site conditions and identifies possible response actions. The HEER Office will select the response action prior to the removal action commencing. Following the removal action the PRP may be required by the HEER Office to publish a public notice of the availability of the Removal Action Report and provide a 30-day comment period if significant public interest is likely.

If at any time during the non-emergency phase of a removal action it is determined by the HEER Office that an emergency removal action is appropriate, the HEER Office will conduct or require a PRP to conduct the emergency action.

Remedial

The remedial response process will be used primarily for sites at which complex site investigations will be required and at which a more extensive evaluation of cleanup alternatives will be required. Complex investigations may be required at sites with complex geology or hydrogeology, sites with extensive ground water contamination, sites with mixtures of contaminants, etc. In addition, if significant public participation activities will be required at several stages of the process, the remedial response process should be followed to allow a greater opportunity for public input into the investigation and cleanup process.

Remedial Investigation

A Remedial Investigation (RI) is required for remedial sites and is intended to assess the facility or vessel conditions to the extent necessary to develop a range of remedial action alternatives to address site conditions. The RI process will be discussed in detail in Section 4 of this manual.

Remedial Action Development and Selection

The purpose of the remedial action development and selection process is to develop and select remedial actions that eliminate, reduce, prevent, minimize, mitigate, or control risks to public health or welfare, the environment, or natural resources. The number and type of alternatives to be analyzed shall be determined at each site, taking into account the scope, characteristics, and complexity of the problem being addressed.

To the extent practical, presumptive remedial actions will be identified and selected at sites where the contamination present can be treated, contained, or disposed of in a manner which has proved successful at similar sites with similar contamination.

A detailed analysis of alternatives shall be conducted on those remedial action alternatives which meet the threshold criteria of complying with applicable laws and protectiveness of human health and the environment. The detailed analysis will be conducted based on the following three evaluation criteria: effectiveness, implementability and cost. A more detailed discussion of this process is described in Section 5.

The HEER Office shall establish, or require PRPs to establish, cleanup levels that are protective of public health or welfare, the environment or natural resources. A more detailed discussion of this process is described in Section 5.

1.5 Criteria for No Further Action

In order for the HEER Office to make a determination of No Further Action at a site, the response action must be protective of human health and the environment. If the four criteria presented below are met, the HEER Office may make a determination of No Further Action.

1. There has been no release of a hazardous substance, pollutant or contaminant to the environment.
2. There is no threat of a release of a hazardous substance, pollutant or contaminant to the environment.
3. The facility is adequately characterized, and
 - a. No hazardous substances remain on site; or
 - b. No significant threat to human health or the environment exists.
4. Response actions are complete and adequate measures have been taken to protect human health and the environment.

1.6 Administrative Record

When issuing an order or selecting a response action, DOH shall base the order or decision on the documents contained in an administrative record. The administrative record forms the basis for issuing an order and for the selection of a response action. If sufficient time does not exist prior to conducting a response action, the administrative record will be completed following the action.

1.7 Public Participation

1.7.1 General

The HEER Office will encourage the participation of all interested parties in all phases of the removal and remedial process. The HEER Office will conduct community relations activities as appropriate to ensure that the public has sufficient information regarding site activities to comment on proposed removal or remedial actions which may affect their community. At sites where the public has expressed a strong interest in commenting on any proposed response action, the HEER Office may elect to utilize the public participation activities described in the remedial action section below regardless of whether the site is being addressed through the removal or remedial process.

1.7.2 Public Participation in the Removal Process

As discussed in Section 1.6, the administrative record for those removal actions requiring public participation activities shall be made available for public inspection no later than 60 days after initiation of on-site removal action. The HEER Office shall provide or require to be provided, a public comment period under the following circumstances. For removal actions conducted by the HEER Office using Fund monies, if based on the site conditions removal costs may exceed \$25,000 or if public or private interests are significant, the HEER Office shall (1) publish a notice of the availability of the administrative record within 60 days of on-site activity, and (2) provide a public comment period of not less than 30 days. For removal actions conducted by potentially responsible parties, if the HEER Office determines that public participation activities are in the public interest or if public or private interests may be significant, PRPs shall (1) publish a notice of the availability of the administrative record within 60 days of on-site activity, and (2) provide a public comment period of not less than 30 days.

1.7.3 Public Participation in the Remedial Process

Under the remedial process, the HEER Office will prepare for public comment a draft

Response Action Memorandum (RAM). The purpose of the draft RAM is to document and make available for public comment the HEER Office's preliminary remedy selection decision. The draft RAM will summarize the site conditions discovered, the problems posed by the site, the remedial alternatives analyzed, the preferred remedial action alternative and the technical aspects of the proposed remedy.

After the draft RAM is prepared, the HEER Office shall conduct, or require to be conducted if appropriate the following public participation activities:

1. Publish a notice of availability of the draft RAM;
2. Make the draft RAM and supporting analysis available in the administrative record;
3. Provide a reasonable opportunity of not less than 30 calendar days for submission of written and oral comments on the draft RAM;
4. Extend the comment period if appropriate;
5. Hold a public meeting, if the department determines that there is sufficient public interest;
6. Prepare and make available a transcript, recording or minutes of any public meeting held.

If after publication of the draft RAM and prior to the selection of the remedial action, the HEER Office receives new information from public comment or other sources that would fundamentally change the remedy with respect to scope, performance, or cost, the HEER Office will:

1. Include a discussion in the final RAM of the fundamental changes and reasons for such changes; or
2. Reopen the public comment period and seek additional public comment on a revised draft RAM if the HEER Office determines that the fundamental changes could not have been reasonably anticipated by the public based on information in the initial draft RAM.

Based on public comments on the draft RAM, the HEER Office will review its proposed remedial action and make a final decision on the remedial action in a final RAM. The HEER Office will then make the final RAM and supporting analysis available to the public prior to commencement of the remedial action.

1.8 DOH Policy

1.8.1 Response and Oversight Deferral

Chapter 128D, HRS, is intended to complement CERCLA and the Resource Conservation and Recovery Act (RCRA) corrective action requirements under Subtitle C and I. In addition, it is generally preferable to defer a response action to the appropriate lead federal or State agency rather than provide duplicative review and oversight. Subsection 128D-22 provides for deferral of response action to other laws, if the result of the action will be consistent with Chapter 128D. As such, sites listed on the National Priorities List (NPL) may be deferred to the U.S. Environmental Protection Agency, except that the HEER Office will have an interest where oil is a significant contaminant. In addition, sites undergoing response actions in compliance with other State laws and consistent with Chapter 128D, will be deferred to the appropriate branch of DOH or other State agency.

1.8.2 Private Party Lead

The HEER Office prefers to have potentially responsible parties undertake response actions with the HEER Office providing oversight. To ensure that proper response activities are undertaken in a timely manner, the HEER Office will endeavor to enter into consent agreements with potentially responsible parties. If necessary, the HEER Office will issue unilateral administrative orders, and may, in some instances, conduct the necessary activities using the Environmental Response Revolving Fund.

Section 2

RELEASE NOTIFICATION

Section 2

RELEASE NOTIFICATION

2.1 Background

Several federal and state statutes require persons in charge of a facility or vessel to notify the appropriate government officials when there is a release of a designated hazardous substance, including oil, in an amount greater than or equal to the reportable quantity for that substance. These statutes are:

1. The Emergency Planning and Community Right-to-Know Act of 1986 (42 U.S.C.A. §§11001 to 11050), commonly known as EPCRA ;
2. The Comprehensive Environmental Response, Compensation and Liability Act (42 U.S.C.A. §§9601 to 9675), commonly known as CERCLA;
3. The Environmental Response Law (Chapter 128D, Hawaii Revised Statutes), commonly known as ERL;
4. The Hawaii Emergency Planning and Community Right-to-Know Act (Chapter 128E, Hawaii Revised Statutes), commonly known as HEPCRA, and;
5. The Underground Storage Tank Law, Chapter 342L, Hawaii Revises Statutes.

In general, notification based on reportable quantities is a trigger for informing government agencies of a release so that the appropriate federal, state or local personnel can evaluate the need for a response action and undertake any necessary action in a timely fashion. Agency personnel will evaluate all reported releases, but will not necessarily initiate a response action in response to all releases. Some reportable quantity releases may not warrant a response action.

In addition to reporting based on reportable quantities, the administrative rules to implement the Environmental Response Law (Hawaii Administrative Rules, Title 11, Chapter 451), also known as the State Contingency Plan, require any person with knowledge of any release of a hazardous substance occurring on or after the effective date of the rules (August 17, 1995) above a reportable quantity shall immediately notify the department as soon as that person has knowledge of that release. Notification under chapter 128D does not exempt any person from complying with all applicable requirements for notification under other state or federal law.

In accordance with §11-451-7(l)(5) of the State Contingency Plan, releases of hazardous substances that are discharged or emitted from an outfall, stack or other point source, or as fugitive emissions, which are regulated under other laws and regulations need not be reported provided the release does not exceed the amount allowed by law or regulation or the release does not pose a substantial endangerment to the public health or welfare or the environment.

2.2 Initial Notification

Any person in charge of a facility or vessel shall immediately notify the appropriate organizations listed in the Appendix (Department of Health and LEPC), of any release of a hazardous substance if the quantity released is equal to or exceeds the reportable quantity (RQ) for that substance. If the release is a quantity of oil less than 25 gallons and is cleaned up within 72 hours, notification to the Department is not required. If the release is less than 25 gallons but is not cleaned up within 72 hours, only written notification is required. Reportable quantities (RQs) are summarized in an Appendix of this Section. Refer to diagram 2-1 to determine the need to report.

Whenever possible initial notifications shall be made by phone. If phone service is not available you are not exempt from the reporting requirements. Notification may include notifications made in person to the department. Notifications transmitted via facsimile machines will not be considered initial notification by the department unless prior approval is granted by the department for special circumstances. Notification to the department shall consist of the following information, but shall not be delayed due to incomplete information:

1. The name (trade and chemical) and chemical abstract service registry number, if available, of the hazardous substance or pollutant or contaminant released or threatened to be released;
2. The approximate quantity of the hazardous substance or pollutant or contaminant which has been released or of which there is a threat of release;
3. The notification threshold(s) that is the basis for the notification;
4. The location of the release or threat of release. The location should also be confirmed by either surveying or the use of a Global Positioning System (GPS) unit which provides latitude and longitude;
5. A brief description of the release or threat of release including the medium or media into which the release occurred or is likely to occur, and the cause of the release or threat of release;

6. The date, time and duration of the release;
7. The source of the release or threat of release;
8. The name, address and telephone number of the caller;
9. The name, address and telephone number of the owner/operator of the site or vessel where a release has occurred or a threat of release exists;
10. The name and telephone number of a contact person at the site or vessel where a release has occurred or a threat of release exists;
11. Measures taken or proposed to be taken in response to the release or threat of release as of the time of the notification;
12. The names of other federal, state or local government agencies that have been notified of the release or threat of release;
13. Any known or anticipated acute or chronic health risks associated with the release and, where appropriate, advice regarding medical attention necessary for exposed individuals; and
14. Any other information, including but without limitation to, potential public health or welfare or environmental impacts, which are relevant to assessing the degree of hazard posed by the release or threat of release.

The Hazardous Substances Incident Notification Form that is used by the department when taking initial release notifications is included as a Appendix to this Section.

2.3 Written Follow-up Report

A written follow-up report shall be submitted by persons in charge of facilities or vessels to the appropriate agencies listed an Appendix to this Section. This written report shall be postmarked no later than thirty (30) days after initial discovery of a release. This report shall be sent via certified mail or another means which provides proof of delivery. The written report shall include all the information required by the initial report and any updated information. As it becomes available, additional information should be supplied to the DOH in subsequent written follow-up reports.

2.4 Reportable Quantities

The State Contingency Plan establishes reportable quantities in §11-451-6. The purpose of requiring immediate notification of the release of a hazardous substance is to provide

the appropriate response agency with timely information for determining the appropriate action to protect human health and the environment.

The failure to provide immediate notification and follow-up notification report as required constitutes a violation of State law and may be subject to penalties. If the specific hazardous substance does not have a listed reportable quantity in the Appendix, reporting may still be required in accordance with the unlisted hazardous substance rule in §11-451-5.

2.4.1 Listed Hazardous Substances

The Appendix contains a list of hazardous substances and their associated reportable quantities. However, it does not contain the reportable quantities for trichloropropane and oil. These specific substances have the following reportable quantities:

Trichloropropane: 10 pounds

Oil: Any amount of oil which when released into the environment causes a sheen to appear on surface water or any navigable water of the State;

Any free product that appears on ground water;

Any amount of oil released to the environment greater than 25 gallons; and

Any amount of oil released to the environment which is less than 25 gallons, but which is not contained or remedied within 72 hours.

2.4.2 Unlisted Hazardous Substances

An unlisted hazardous substance is a hazardous waste which exhibits any of the characteristics of ignitability, corrosivity, reactivity, or toxicity as described in 40 CFR Part 261.21. For these substances the reportable quantity is 100 pounds, **except if the hazardous substance is a regulated hazardous waste which exhibits toxicity characteristics when tested using EPA method 1311** (Toxicity Characteristic Leaching Procedure or "TCLP".) If the hazardous waste exhibits the toxicity characteristic, the reportable quantity will be the specific quantity listed in appendix 2A for the constituent for which the waste is toxic. The mixture rule does not apply to unlisted hazardous substances.

Example:

A generator of a hazardous waste accidentally releases 5 pounds of the waste into the environment. The generator knows from past experience and testing that the

waste is hazardous based upon the RCRA Toxicity Characteristic Leachate Procedure (TCLP) test. The waste leaches 10 mg/L arsenic using the TCLP test which is above the regulatory level for arsenic of 5 mg/L. Therefore, the generator has determined that a release of an unlisted hazardous substance has occurred, in accordance with §11-451-5.

Subsection 11-451-6(c) specifies the reportable quantity for unlisted hazardous substances as 100 pounds, except if it is an unlisted hazardous waste which exhibits the toxicity characteristic. Since this hazardous waste does exhibit the toxicity characteristics, the generator must comply with paragraph 11-451-6(c)(2) to determine the reportable quantity. In general, the referenced paragraph indicates how to determine the reportable quantity for characteristic hazardous wastes. At the end of paragraph 11-451-6(c)(2) it states "[the reportable quantities described in this paragraph apply to the weight of the entire amount of material released, not merely to the hazardous component".

By referring to the appendix, the generator discovers that the reportable quantity for arsenic is 1 pound. Since the quantity of waste released equaled 5 pounds and the mixture rule does not apply, report of a release of 5 pounds of arsenic into the environment must be made.

If the waste is hazardous due to one or more toxicity factors (i.e., lead and chromium), then the reportable quantity is the lower of the two toxic constituents. However, if the hazardous waste is a toxicity characteristic waste and also meets the definition of a hazardous waste due to one or more of the other characteristics (reactivity, ignitability, or corrosivity) then the reportable quantity is based on the lowest of the hazardous waste constituent's or characteristic's reportable quantity, where the quantity is determined by the entire amount released. The mixture rule does not apply to unlisted hazardous substances.

Example:

A generator of a hazardous waste accidentally releases 110 pounds of the waste into the environment. The generator knows from past experience and testing that the waste is hazardous based upon the RCRA TCLP test and that the waste is ignitable. The waste leaches 250 mg/L using the TCLP test which is above the regulatory level for Methyl Ethyl Ketone of 200 mg/L and the waste exhibits an ignitable characteristic. Therefore, the generator has determined that he has an unlisted hazardous substance according to section 11-451-5. (See Example above for determination of reportable quantities)

By referring to the appendix the generator discovers that the reportable quantity for Methyl Ethyl Ketone is 5000 pounds and the reportable quantity for an ignitable

waste is 100 pounds. Since 110 pounds of the waste was released and the entire waste is ignitable and the mixture rule does not apply, a report of a release of 110 pounds of an ignitable waste containing Methyl Ethyl Ketone into the environment must be made.

2.4.3 Hazardous Substance Mixtures & Solutions

Releases of mixtures or solutions or both are subject to these reporting requirements when the exact quantity of all the hazardous components in the mixture or solution is known and the amount is equal or greater than the reportable quantity (RQ) of any hazardous constituent is released.

Example:

Hazardous chemical XYZ is in a 20% solution with other inert, non-hazardous chemicals, the reportable quantity for XYZ is 10 pounds, therefore a spill equal to or greater than 50 pounds of the mixture would trigger the reporting requirements for chemical XYZ. If the quantity of any of the hazardous components of the mixture or solution is unknown, notification is required where the total amount of the mixture or solution released equals or exceeds the RQ for the hazardous constituent with the lowest RQ.

Example: Hazardous chemical ABC is known to be a mixture containing benzene; the exact composition is unknown. Since the RQ for benzene is 10 pounds then any release of the mixture that would be equal to or in excess of 10 pounds would be required to be reported.

2.5 Failure to Report

In accordance with HRS 128 D-3(c), any person who fails to report a hazardous substance release to the Department immediately upon knowledge of the release shall be subject to a civil penalty in an amount not to exceed \$10,000 for each day of failure to report or subject to prosecution for a criminal misdemeanor.

In accordance with HEPCRA §128E-11, any person who violates any of the emergency reporting, planning, or notification requirements or fails to pay the required fees shall be subject to a civil penalty of not less than \$1,000 but not more than \$25,000 for each separate offense. Each day of violation shall constitute a separate offense. Any person who knowingly fails to report the release of a hazardous substance or extremely hazardous substance as required by HEPCRA may be guilty of a misdemeanor and upon conviction, be fined not less than \$1,000 but not more than \$25,000 for each separate offense, or imprisoned for not more than one year, or both. Each day of each violation shall constitute a separate offense.

In addition, any person who intentionally obstructs or impairs, by force, violence, physical interference, or obstacle, a representative of the Department, a hazardous materials response team, or a committee attempting to perform the duties and functions set forth in HEPCRA shall be guilty of a misdemeanor and upon conviction, be fined not less than \$5,000 but not more than \$25,000 for each separate offense, or be imprisoned for not more than one year, or both.

Section 2

APPENDICES

Reportable Quantities

HSERC Listing

Hazardous Substances Inventory Guideline

Hazardous Substance Release Notification Guidelines and Incident
Hazardous Substance Notification Form

Written Follow Up Form

Section 2

Appendix 2A

Reportable Quantities

| CAS | NAME | RCRACODE | State RQ |
|-------|--|----------|----------|
| 0 | Antimony Compounds | | ** |
| 0 | Arsenic Compounds | | ** |
| 0 | Beryllium Compounds | | ** |
| 0 | Cadmium Compounds | | ** |
| 0 | Chlordane (Technical Mixture and Metabolites) | | ** |
| 0 | Chlorinated Benzenes | | ** |
| 0 | Chlorinated Ethanes | | ** |
| 0 | Chlorinated Naphthalene | | ** |
| 0 | Chlorinated Phenols | | ** |
| 0 | Chloroalkyl Ethers | | ** |
| 0 | Chlorophenols | | ** |
| 0 | Chromium Compounds | | ** |
| 0 | Cobalt Compounds | | * |
| 0 | Coke Oven Emissions | | 1 |
| 0 | Copper Compounds | | ** |
| 0 | Cyanide Compounds | | ** |
| 0 | DDT and Metabolites | | ** |
| 0 | Dichlorobenzidine | | ** |
| 0 | Diphenylhydrazine | | ** |
| 0 | Endosulfan and Metabolites | | ** |
| 0 | Endrin and Metabolites | | ** |
| 0 | Glycol Ethers | | * |
| 0 | Haloethers | | ** |
| 0 | Halomethanes | | ** |
| 0 | Heptachlor and Metabolites | | ** |
| 0 | Hexachlorocyclohexane (all isomers) CAS 608-73-1 | | ** |
| 0 | Lead Compounds | | ** |
| 0 | Manganese Compounds | | * |
| 0 | Manganese Compounds | | * |
| 0 | Mercury Compounds | | ** |
| 0 | Fine mineral fibers | | * |
| 0 | Nickel Compounds | | ** |
| 0 | Nitrophenols | | ** |
| 0 | Nitrosamines | | ** |
| 0 | Organorhodium Complex (PMN-82-147) | | 1 |
| 0 | Phthalate Esters | | ** |
| 0 | Polycyclic organic matter | | * |
| 0 | Polynuclear Aromatic Hydrocarbons | | ** |
| 0 | Selenium Compounds | | ** |
| 0 | Silver Compounds | | ** |
| 0 | Thallium Compounds | | ** |
| 0 | Zinc Compounds | | ** |
| 50000 | Formaldehyde | U122 | 100 |
| 50077 | Mitomycin C | U010 | 10 |
| 50146 | Ergocalciferol | | 1 |
| 50180 | Cyclophosphamide | U058 | 10 |
| 50293 | DDT | U061 | 1 |
| 50328 | Benzo[a]pyrene | U022 | 1 |
| 50555 | Reserpine | U200 | 5000 |
| 51218 | Fluorouracil | | 1 |
| 51285 | "2,4-Dinitrophenol" | P048 | 10 |
| 51434 | Epinephrine | P042 | 1000 |
| 51752 | Mechlorethamine | | 1 |
| 51796 | "Carbamic acid, ethyl ester" | U238 | 100 |
| 51796 | Ethyl carbamate | U238 | 100 |

| | | | |
|-------|---|------|------|
| 51796 | Urethane | U238 | 100 |
| 51832 | Carbachol chloride | | 1 |
| 52686 | Trichlorfon | | 100 |
| 52857 | Famphur | P097 | 1000 |
| 53703 | "Dibenz[a,h]anthracene" | U063 | 1 |
| 53963 | 2-Acetylaminofluorene | U005 | 1 |
| 54115 | Nicotine | P075 | 100 |
| 54115 | Nicotine and salts | P075 | 100 |
| 54115 | "Pyridine, 3-(1-methyl-2-pyrrolidinyl)-,(S)-" | P075 | 100 |
| 54626 | Aminopterin | | 1 |
| 55185 | N-Nitrosodiethylamine | U174 | 1 |
| 55630 | Nitroglycerin | P081 | 10 |
| 55914 | Diisopropylfluorophosphate | P043 | 100 |
| 55914 | Isofluorophate | P043 | 100 |
| 56042 | Methylthiouracil | U164 | 10 |
| 56235 | Carbon tetrachloride | U211 | 10 |
| 56257 | Cantharidin | | 1 |
| 56382 | Parathion | P089 | 10 |
| 56495 | 3-Methylcholanthrene | U157 | 10 |
| 56531 | Diethylstilbestrol | U089 | 1 |
| 56553 | Benz[a]anthracene | U018 | 10 |
| 56724 | Coumaphos | | 10 |
| 57125 | Cyanides (soluble salts and complexes) | P030 | 10 |
| 57147 | "1,1-Dimethyl hydrazine" | U098 | 10 |
| 57147 | Dimethylhydrazine | U098 | 10 |
| 57147 | "Hydrazine, 1,1-dimethyl-" | U098 | 10 |
| 57249 | Strychnine | P108 | 10 |
| 57249 | "Strychnine, and salts" | P108 | 10 |
| 57476 | Physostigmine | | 1 |
| 57578 | beta-Propiolactone | | 10 |
| 57647 | "Physostigmine, salicylate (1:1)" | | 1 |
| 57749 | Chlordane | U036 | 1 |
| 57976 | "7,12-Dimethylbenz[a]anthracene" | U094 | 1 |
| 58366 | "Phenoxarsine, 10,10'-oxydi-" | | 1 |
| 58899 | Hexachlorocyclohexane (gamma isomer) | U129 | 1 |
| 58899 | Lindane | U129 | 1 |
| 58902 | "2,3,4,6-Tetrachlorophenol" | U212 | 10 |
| 59507 | p-Chloro-m-cresol | U039 | 5000 |
| 59881 | Phenylhydrazine hydrochloride | | 1 |
| 59892 | N-Nitrosomorpholine | | 1 |
| 60004 | Ethylenediamine-tetraacetic acid (EDTA) | | 5000 |
| 60117 | 4-Dimethylaminoazobenzene | U093 | 10 |
| 60117 | Dimethylaminoazobenzene | U093 | 10 |
| 60297 | Ethyl ether | U117 | 100 |
| 60344 | Methyl hydrazine | P068 | 10 |
| 60355 | Acetamide | | 100 |
| 60413 | "Strychnine, sulfate" | | 10 |
| 60515 | Dimethoate | P044 | 10 |
| 60571 | Dieldrin | P037 | 1 |
| 61825 | Amitrole | U011 | 10 |
| 62384 | Phenylmercuric acetate | P092 | 100 |
| 62384 | Phenylmercury acetate | P092 | 100 |
| 62442 | Phenacetin | U187 | 100 |
| 62500 | Ethyl methanesulfonate | U119 | 1 |
| 62533 | Aniline | U012 | 5000 |
| 62555 | Thioacetamide | U218 | 10 |

| | | | |
|-------|---|------|------|
| 62566 | Thiourea | U219 | 10 |
| 62737 | Dichlorvos | | 10 |
| 62748 | "Fluoroacetic acid, sodium salt" | P058 | 10 |
| 62748 | Sodium fluoroacetate | P058 | 10 |
| 62759 | "Methanamine, N-methyl-N-nitroso-" | P082 | 10 |
| 62759 | N-Nitrosodimethylamine | P082 | 10 |
| 62759 | Nitrosodimethylamine | P082 | 10 |
| 63252 | Carbaryl | | 100 |
| 64006 | "Phenol, 3-(1-methylethyl)-, methylcarbamate" | | 1 |
| 64186 | Formic acid | U123 | 5000 |
| 64197 | Acetic acid | | 5000 |
| 64675 | Diethyl sulfate | | 10 |
| 64868 | Colchicine | | 1 |
| 65305 | Nicotine sulfate | | 100 |
| 65850 | Benzoic acid | | 5000 |
| 66751 | Uracil mustard | U237 | 10 |
| 66819 | Cycloheximide | | 1 |
| 67561 | Methanol | U154 | 5000 |
| 67641 | Acetone | U002 | 5000 |
| 67663 | Chloroform | U044 | 10 |
| 67721 | Hexachloroethane | U131 | 100 |
| 68122 | Dimethylformamide | | 10 |
| 70257 | "Guanidine, N-methyl-N'-nitro-N-nitroso-" | U163 | 10 |
| 70304 | Hexachlorophene | U132 | 100 |
| 70699 | "Propiophenone, 4'-amino" | | 1 |
| 71363 | n-Butyl alcohol | U031 | 5000 |
| 71432 | Benzene | U019 | 10 |
| 71556 | Methyl chloroform | U226 | 1000 |
| 71556 | "1,1,1-Trichloroethane" | U226 | 1000 |
| 71636 | Digitoxin | | 1 |
| 72208 | Endrin | P051 | 1 |
| 72435 | Methoxychlor | U247 | 1 |
| 72548 | DDD | U060 | 1 |
| 72559 | DDE | | 1 |
| 72571 | Trypan blue | U236 | 10 |
| 74839 | Bromomethane | U029 | 1000 |
| 74839 | Methyl bromide | U029 | 1000 |
| 74873 | Chloromethane | U045 | 100 |
| 74873 | Methyl chloride | U045 | 100 |
| 74884 | Methyl iodide | U138 | 100 |
| 74895 | Monomethylamine | | 100 |
| 74908 | Hydrocyanic acid | P063 | 10 |
| 74908 | Hydrogen cyanide | P063 | 10 |
| 74931 | Methyl mercaptan | U153 | 100 |
| 74931 | Thiomethanol | U153 | 100 |
| 74953 | Methylene bromide | U068 | 1000 |
| 75003 | Chloroethane | | 100 |
| 75003 | Ethyl chloride | | 100 |
| 75014 | Vinyl chloride | U043 | 1 |
| 75047 | Monoethylamine | | 100 |
| 75058 | Acetonitrile | U003 | 5000 |
| 75070 | Acetaldehyde | U001 | 1000 |
| 75092 | Dichloromethane | U080 | 1000 |
| 75092 | Methylene chloride | U080 | 1000 |
| 75150 | Carbon disulfide | P022 | 100 |
| 75207 | Calcium carbide | | 10 |

| | | | |
|-------|-----------------------------------|------|------|
| 75218 | Ethylene oxide | U115 | 10 |
| 75218 | Oxirane | U115 | 10 |
| 75252 | Bromoform | U225 | 100 |
| 75252 | Tribromomethane | U225 | 100 |
| 75274 | Dichlorobromomethane | | 5000 |
| 75343 | "1,1-Dichloroethane" | U076 | 1000 |
| 75354 | "1,1-Dichloroethylene" | U078 | 100 |
| 75354 | Vinylidene chloride | U078 | 100 |
| 75365 | Acetyl chloride | U006 | 5000 |
| 75445 | Phosgene | P095 | 10 |
| 75503 | Trimethylamine | | 100 |
| 75558 | "Aziridine, 2-methyl" | P067 | 1 |
| 75558 | Propyleneimine | P067 | 1 |
| 75569 | Propylene oxide | | 100 |
| 75605 | Cacodylic acid | U136 | 1 |
| 75649 | tert-Butylamine | | 1000 |
| 75694 | CFC-11 | U121 | 5000 |
| 75694 | Trichlorofluoromethane [CFC-11] | U121 | 5000 |
| 75694 | Trichloromonofluoromethane | U121 | 5000 |
| 75718 | CFC-12 | U075 | 5000 |
| 75718 | Dichlorodifluoromethane [CFC-12] | U075 | 5000 |
| 75741 | Tetramethyllead | | 1 |
| 75774 | Trimethylchlorosilane | | 1 |
| 75785 | Dimethyldichlorosilane | | 1 |
| 75796 | Methyltrichlorosilane | | 1 |
| 75865 | Acetone cyanohydrin | P069 | 10 |
| 75876 | "Acetaldehyde, trichloro-" | U034 | 5000 |
| 75990 | "2,2-Dichloropropionic acid" | | 5000 |
| 76017 | Pentachloroethane | U184 | 10 |
| 76028 | Trichloroacetyl chloride | | 1 |
| 76448 | Heptachlor | P059 | 1 |
| 77474 | Hexachlorocyclopentadiene | U130 | 10 |
| 77781 | Dimethyl sulfate | U103 | 100 |
| 77816 | Tabun | | 1 |
| 78002 | Tetraethyl lead | P110 | 10 |
| 78342 | Dioxathion | | 1 |
| 78535 | Amiton | | 1 |
| 78591 | Isophorone | | 5000 |
| 78717 | "Oxetane, 3,3-bis(chloromethyl)-" | | 1 |
| 78795 | Isoprene | | 100 |
| 78819 | iso-Butylamine | | 1000 |
| 78820 | Isobutyronitrile | | 1 |
| 78831 | Isobutyl alcohol | U140 | 5000 |
| 78875 | "1,2-Dichloropropane" | U083 | 1000 |
| 78875 | "Propane 1,2-dichloro-" | U083 | 1000 |
| 78886 | "2,3-Dichloropropene" | | 100 |
| 78933 | Methyl ethyl ketone | U159 | 5000 |
| 78933 | Methyl ethyl ketone (MEK) | U159 | 5000 |
| 78944 | Methyl vinyl ketone | | 1 |
| 78977 | Lactonitrile | | 1 |
| 78999 | "1,1-Dichloropropane" | | 1000 |
| 79005 | "1,1,2-Trichloroethane" | U227 | 100 |
| 79016 | Trichloroethylene | U228 | 100 |
| 79061 | Acrylamide | U007 | 5000 |
| 79094 | Propionic acid | | 5000 |
| 79107 | Acrylic acid | U008 | 5000 |

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| 79118 | Chloroacetic acid | | 100 |
| 79196 | Thiosemicarbazide | P116 | 100 |
| 79210 | Peracetic acid | | 1 |
| 79221 | Methyl chloroformate | U156 | 1000 |
| 79312 | iso-Butyric acid | | 5000 |
| 79345 | "1,1,2,2-Tetrachloroethane" | U209 | 100 |
| 79447 | Dimethylcarbamyl chloride | U097 | 1 |
| 79469 | 2-Nitropropane | U171 | 10 |
| 80159 | Cumene hydroperoxide | U096 | 10 |
| 80159 | "Hydroperoxide, 1-methyl-1-phenylethyl-" | U096 | 10 |
| 80626 | Methyl methacrylate | U162 | 1000 |
| 80637 | Methyl 2-chloroacrylate | | 1 |
| 81072 | Saccharin (manufacturing) | U202 | 100 |
| 81072 | Saccharin and salts | U202 | 100 |
| 81812 | Warfarin | P001 | 100 |
| 81812 | "Warfarin, & salts, conc.>0.3%" | P001 | 100 |
| 82666 | Diphacinone | | 1 |
| 82688 | PCNB | U185 | 100 |
| 82688 | Pentachloronitrobenzene | U185 | 100 |
| 82688 | Quintozone | U185 | 100 |
| 83329 | Acenaphthene | | 100 |
| 84662 | Diethyl phthalate | U088 | 1000 |
| 84742 | n-Butyl phthalate | U069 | 10 |
| 84742 | Dibutyl phthalate | U069 | 10 |
| 85007 | Diquat | | 1000 |
| 85018 | Phenanthrene | | 5000 |
| 85449 | Phthalic anhydride | U190 | 5000 |
| 85687 | Butyl benzyl phthalate | | 100 |
| 86306 | N-Nitrosodiphenylamine | | 100 |
| 86500 | Azinphos-methyl | | 1 |
| 86500 | Guthion | | 1 |
| 86737 | Fluorene | | 5000 |
| 86884 | Antu | P072 | 100 |
| 86884 | "Thiourea, 1-naphthalenyl-" | P072 | 100 |
| 87650 | "2,6-Dichlorophenol" | U082 | 100 |
| 87683 | "Hexachloro-1,3-butadiene" | U128 | 1 |
| 87683 | Hexachlorobutadiene | U128 | 1 |
| 87865 | PCP | U242 | 10 |
| 87865 | Pentachlorophenol | U242 | 10 |
| 88051 | "Aniline, 2,4,6-trimethyl-" | | 1 |
| 88062 | "2,4,6-Trichlorophenol" | U231 | 10 |
| 88722 | o-Nitrotoluene | | 1000 |
| 88755 | 2-Nitrophenol | | 100 |
| 88857 | Dinoseb | P020 | 1000 |
| 90040 | o-Anisidine | | 100 |
| 91087 | "Toluene-2,6-diisocyanate" | | 100 |
| 91203 | Naphthalene | U165 | 100 |
| 91225 | Quinoline | | 5000 |
| 91587 | 2-Chloronaphthalene | U047 | 5000 |
| 91598 | beta-Naphthylamine | U168 | 10 |
| 91667 | "N,N-Diethylaniline" | | 1000 |
| 91805 | Methapyrilene | U155 | 5000 |
| 91941 | "3,3'-Dichlorobenzidine" | U073 | 1 |
| 92524 | Biphenyl | | 100 |
| 92671 | 4-Aminobiphenyl | | 1 |
| 92875 | Benzidine | U021 | 1 |

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| 92933 | 4-Nitrobiphenyl | | 10 |
| 93721 | "Silvex (2,4,5-TP)" | U233 | 100 |
| 93765 | "2,4,5-T acid" | U232 | 1000 |
| 93798 | "2,4,5-T esters" | | 1000 |
| 94111 | "2,4-D Esters" | | 100 |
| 94586 | Dihydrosafrole | U090 | 10 |
| 94597 | Safrole | U203 | 100 |
| 94757 | "2,4-D" | U240 | 100 |
| 94757 | "2,4-D Acid" | U240 | 100 |
| 94757 | "2,4-D, salts and esters" | U240 | 100 |
| 94791 | "2,4-D Esters" | | 100 |
| 94804 | "2,4-D Esters" | | 100 |
| 95476 | "Benzene, o-dimethyl-" | U239 | 1000 |
| 95476 | o-Xylene | U239 | 1000 |
| 95487 | o-Cresol | U052 | 100 |
| 95501 | o-Dichlorobenzene | U070 | 100 |
| 95501 | "1,2-Dichlorobenzene" | U070 | 100 |
| 95534 | o-Toluidine | U328 | 100 |
| 95578 | 2-Chlorophenol | U048 | 100 |
| 95807 | "2,4-Diaminotoluene" | | 10 |
| 95943 | "1,2,4,5-Tetrachlorobenzene" | U207 | 5000 |
| 95954 | "2,4,5-Trichlorophenol" | U230 | 10 |
| 96093 | Styrene oxide | | 100 |
| 96128 | DBCP | U066 | 1 |
| 96128 | "1,2-Dibromo-3-chloropropane" | U066 | 1 |
| 96457 | Ethylene thiourea | U116 | 10 |
| 97632 | Ethyl methacrylate | U118 | 1000 |
| 98011 | Furfural | U125 | 5000 |
| 98055 | Benzenearsonic acid | | 1 |
| 98077 | Benzoic trichloride | U023 | 10 |
| 98077 | Benzotrichloride | U023 | 10 |
| 98099 | Benzenesulfonyl chloride | U020 | 100 |
| 98135 | Trichlorophenylsilane | | 1 |
| 98168 | "Benzenamine, 3-(trifluoromethyl)-" | | 1 |
| 98828 | Cumene | U055 | 5000 |
| 98862 | Acetophenone | U004 | 5000 |
| 98873 | Benzal chloride | U017 | 5000 |
| 98884 | Benzoyl chloride | | 1000 |
| 98953 | Nitrobenzene | U169 | 1000 |
| 99081 | m-Nitrotoluene | | 1000 |
| 99354 | "1,3,5-Trinitrobenzene" | U234 | 10 |
| 99558 | 5-Nitro-o-toluidine | U181 | 100 |
| 99650 | m-Dinitrobenzene | | 100 |
| 99989 | Dimethyl-p-phenylenediamine | | 1 |
| 99990 | p-Nitrotoluene | | 1000 |
| 100016 | p-Nitroaniline | P077 | 5000 |
| 100027 | p-Nitrophenol | U170 | 100 |
| 100027 | 4-Nitrophenol | U170 | 100 |
| 100141 | "Benzene, 1-(chloromethyl)-4-nitro-" | | 1 |
| 100254 | p-Dinitrobenzene | | 100 |
| 100414 | Ethylbenzene | | 1000 |
| 100425 | Styrene | | 1000 |
| 100447 | Benzyl chloride | P028 | 100 |
| 100470 | Benzonitrile | | 5000 |
| 100754 | N-Nitrosopiperidine | U179 | 10 |
| 101144 | MBOCA | U158 | 10 |

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| 101144 | "4,4'-Methylenebis(2-chloroaniline)" | U158 | 10 |
| 101553 | 4-Bromophenyl phenyl ether | U030 | 100 |
| 101688 | MBI | | 5000 |
| 101688 | Methylenebis(phenylisocyanate) | | 5000 |
| 101779 | "4,4'-Methylenedianiline" | | 10 |
| 102363 | "Isocyanic acid, 3,4-dichlorophenyl ester" | | 1 |
| 103855 | Phenylthiourea | P093 | 100 |
| 105464 | sec-Butyl acetate | | 5000 |
| 105602 | Caprolactam | | 5000 |
| 105679 | "2,4-Dimethylphenol" | U101 | 100 |
| 106423 | "Benzene, p-dimethyl-" | U239 | 100 |
| 106423 | p-Xylene | U239 | 100 |
| 106445 | p-Cresol | U052 | 100 |
| 106467 | "1,4-Dichlorobenzene" | U072 | 100 |
| 106478 | p-Chloroaniline | P024 | 1000 |
| 106490 | p-Toluidine | U353 | 100 |
| 106503 | p-Phenylenediamine | | 5000 |
| 106514 | p-Benzoquinone | U197 | 10 |
| 106514 | Quinone | U197 | 10 |
| 106887 | "1,2-Butylene oxide" | | 100 |
| 106898 | Epichlorohydrin | U041 | 100 |
| 106934 | "1,2-Dibromoethane" | U067 | 1 |
| 106934 | Ethylene dibromide | U067 | 1 |
| 106967 | Propargyl bromide | | 1 |
| 106990 | "1,3-Butadiene" | | 10 |
| 107028 | Acrolein | P003 | 1 |
| 107051 | Allyl chloride | | 1000 |
| 107062 | "1,2-Dichloroethane" | U077 | 100 |
| 107062 | Ethylene dichloride | U077 | 100 |
| 107073 | Chloroethanol | | 1 |
| 107108 | n-Propylamine | U194 | 5000 |
| 107119 | Allylamine | | 1 |
| 107120 | Ethyl cyanide | P101 | 10 |
| 107120 | Propionitrile | P101 | 10 |
| 107131 | Acrylonitrile | U009 | 100 |
| 107153 | Ethylenediamine | | 5000 |
| 107164 | Formaldehyde cyanohydrin | | 1 |
| 107186 | Allyl alcohol | P005 | 100 |
| 107197 | Propargyl alcohol | P102 | 1000 |
| 107200 | Chloroacetaldehyde | P023 | 1000 |
| 107211 | Ethylene glycol | | 5000 |
| 107302 | Chloromethyl methyl ether | U046 | 10 |
| 107448 | Sarin | | 1 |
| 107493 | Tepp | P111 | 10 |
| 107493 | Tetraethyl pyrophosphate | P111 | 10 |
| 107926 | Butyric acid | | 5000 |
| 108054 | Vinyl acetate monomer | | 5000 |
| 108054 | Vinyl acetate | | 5000 |
| 108101 | Methyl isobutyl ketone | U161 | 5000 |
| 108236 | Isopropyl chloroformate | | 1 |
| 108247 | Acetic anhydride | | 5000 |
| 108316 | Maleic anhydride | U147 | 5000 |
| 108383 | "Benzene, m-dimethyl-" | U239 | 100 |
| 108383 | m-Xylene | U239 | 100 |
| 108394 | m-Cresol | U052 | 100 |
| 108463 | Resorcinol | U201 | 5000 |

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| 108601 | Bis(2-chloro-1-methylethyl)ether | U027 | 1000 |
| 108601 | Dichloroisopropyl ether | U027 | 1000 |
| 108883 | Toluene | U220 | 1000 |
| 108907 | Chlorobenzene | U037 | 100 |
| 108918 | Cyclohexylamine | | 1 |
| 108941 | Cyclohexanone | U057 | 5000 |
| 108952 | Phenol | U188 | 1000 |
| 108985 | Benzenethiol | P014 | 100 |
| 108985 | Thiophenol | P014 | 100 |
| 109068 | 2-Picoline | U191 | 5000 |
| 109615 | Propyl chloroformate | | 1 |
| 109739 | Butylamine | | 1000 |
| 109773 | Malononitrile | U149 | 1000 |
| 109897 | Diethylamine | | 100 |
| 109999 | "Furan, tetrahydro-" | U213 | 1000 |
| 110009 | Furan | U124 | 100 |
| 110167 | Maleic acid | | 5000 |
| 110178 | Fumaric acid | | 5000 |
| 110190 | iso-Butyl acetate | | 5000 |
| 110543 | Hexane | | 5000 |
| 110576 | "Trans-1,4-dichlorobutene" | | 1 |
| 110758 | 2-Chloroethyl vinyl ether | U042 | 1000 |
| 110805 | "Ethanol, 2-ethoxy-" | U359 | 1000 |
| 110805 | 2-Ethoxyethanol | U359 | 1000 |
| 110827 | Cyclohexane | U056 | 1000 |
| 110861 | Pyridine | U196 | 1000 |
| 110894 | Piperidine | | 1 |
| 111422 | Diethanolamine | | 100 |
| 111444 | Bis(2-chloroethyl) ether | U025 | 10 |
| 111444 | Dichloroethyl ether | U025 | 10 |
| 111546 | "Ethylenebisdithiocarbamic acid, salts & esters" | U114 | 5000 |
| 111693 | Adiponitrile | | 1 |
| 111911 | Bis(2-chloroethoxy) methane | U024 | 1000 |
| 114261 | Propoxur | | 100 |
| 115026 | Azaserine | U015 | 1 |
| 115219 | Trichloroethylsilane | | 1 |
| 115264 | Dimefox | | 1 |
| 115297 | Endosulfan | P050 | 1 |
| 115322 | Dicofol | | 10 |
| 115902 | Fensulfthion | | 1 |
| 116063 | Aldicarb | P070 | 1 |
| 117806 | Dichlone | | 1 |
| 117817 | Bis(2-ethylhexyl)phthalate | U028 | 100 |
| 117817 | DEHP | U028 | 100 |
| 117817 | Di(2-ethylhexyl) phthalate | U028 | 100 |
| 117840 | n-Dioctylphthalate | U107 | 5000 |
| 117840 | Di-n-octyl phthalate | U107 | 5000 |
| 118741 | Hexachlorobenzene | U127 | 10 |
| 119380 | Isopropylmethylpyrazolyl dimethylcarbamate | | 1 |
| 119904 | "3,3'-Dimethoxybenzidine" | U091 | 100 |
| 119937 | "3,3'-Dimethylbenzidine" | U095 | 10 |
| 119937 | o-Tolidine | U095 | 10 |
| 120127 | Anthracene | | 5000 |
| 120581 | Isosafrole | U141 | 100 |
| 120809 | Catechol | | 100 |
| 120821 | "1,2,4-Trichlorobenzene" | | 100 |

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| 120832 | "2,4-Dichlorophenol" | U081 | 100 |
| 121142 | "2,4-Dinitrotoluene" | U105 | 10 |
| 121211 | Pyrethrins | | 1 |
| 121299 | Pyrethrins | | 1 |
| 121448 | Triethylamine | | 5000 |
| 121697 | "N,N-Dimethylaniline" | | 100 |
| 121755 | Malathion | | 100 |
| 122098 | "Benzeneethanamine, alpha,alpha-dimethyl-" | P046 | 5000 |
| 122145 | Fenitrothion | | 1 |
| 122394 | Diphenylamine | | 100 |
| 122667 | "1,2-Diphenylhydrazine" | U109 | 10 |
| 122667 | "Hydrazine, 1,2-diphenyl-" | U109 | 10 |
| 122667 | Hydrazobenzene | U109 | 10 |
| 123319 | Hydroquinone | | 100 |
| 123331 | Maleic hydrazide | U148 | 5000 |
| 123386 | Propionaldehyde | | 1000 |
| 123626 | Propionic anhydride | | 5000 |
| 123637 | Paraldehyde | U182 | 1000 |
| 123739 | "Crotonaldehyde, (E)-" | U053 | 100 |
| 123864 | Butyl acetate | | 5000 |
| 123911 | "1,4-Dioxane" | U108 | 100 |
| 123922 | iso-Amyl acetate | | 5000 |
| 124049 | Adipic acid | | 5000 |
| 124403 | Dimethylamine | U092 | 1000 |
| 124414 | Sodium methylate | | 1000 |
| 124481 | Chlorodibromomethane | | 100 |
| 124652 | Sodium cacodylate | | 1 |
| 124878 | Picrotoxin | | 1 |
| 126727 | "Tris(2,3-dibromopropyl) phosphate" | U235 | 10 |
| 126987 | Methacrylonitrile | U152 | 1000 |
| 126998 | Chloroprene | | 100 |
| 127184 | Perchloroethylene | U210 | 100 |
| 127184 | Tetrachloroethylene | U210 | 100 |
| 127822 | Zinc phenolsulfonate | | 5000 |
| 129000 | Pyrene | | 5000 |
| 129066 | Warfarin sodium | | 100 |
| 130154 | "1,4-Naphthoquinone" | U166 | 5000 |
| 131113 | Dimethyl phthalate | U102 | 5000 |
| 131748 | Ammonium picrate | P009 | 10 |
| 131895 | "2-Cyclohexyl-4,6-Dinitrophenol" | P034 | 100 |
| 132649 | Dibenzofuran | | 100 |
| 133062 | Captan | | 10 |
| 133904 | Chloramben | | 100 |
| 134327 | alpha-Naphthylamine | U167 | 100 |
| 137268 | Thiram | U244 | 10 |
| 140294 | Benzyl cyanide | | 1 |
| 140761 | "Pyridine, 2-methyl-5-vinyl-" | | 1 |
| 140885 | Ethyl acrylate | U113 | 1000 |
| 141662 | Dicrotophos | | 1 |
| 141786 | Ethyl acetate | U112 | 5000 |
| 142289 | "1,3-Dichloropropane" | | 1000 |
| 142712 | Cupric acetate | | 100 |
| 142847 | Dipropylamine | U110 | 5000 |
| 143339 | Sodium cyanide (Na(CN)) | P106 | 10 |
| 143500 | Kepone | U142 | 1 |
| 144490 | Fluoroacetic acid | | 1 |

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| 145733 | Endothall | P088 | 1000 |
| 148823 | Melphalan | U150 | 1 |
| 149746 | Dichloromethylphenylsilane | | 1 |
| 151382 | Methoxyethylmercuric acetate | | 1 |
| 151508 | Potassium cyanide | P098 | 10 |
| 151564 | Aziridine | P054 | 1 |
| 151564 | Ethyleneimine | P054 | 1 |
| 152169 | "Diphosphoramidate, octamethyl-" | P085 | 100 |
| 156605 | "1,2-Dichloroethylene" | U079 | 1000 |
| 156627 | Calcium cyanamide | | 1000 |
| 189559 | "Dibenz[a,i]pyrene" | U064 | 10 |
| 191242 | Benzo[ghi]perylene | | 5000 |
| 193395 | "Indeno(1,2,3-cd)pyrene" | U137 | 100 |
| 205992 | Benzo[b]fluoranthene | | 1 |
| 206440 | Fluoranthene | U120 | 100 |
| 207089 | Benzo(k)fluoranthene | | 5000 |
| 208968 | Acenaphthylene | | 5000 |
| 218019 | Chrysene | U050 | 100 |
| 225514 | Benz[c]acridine | U016 | 100 |
| 297789 | Isobenzan | | 1 |
| 297972 | "O,O-Diethyl O-pyrazinyl phosphorothioate" | P040 | 100 |
| 297972 | Thionazin | P040 | 100 |
| 298000 | Methyl parathion | P071 | 100 |
| 298000 | Parathion-methyl | P071 | 100 |
| 298022 | Phorate | P094 | 10 |
| 298044 | Disulfoton | P039 | 1 |
| 300629 | Amphetamine | | 1 |
| 300765 | Naled | | 10 |
| 301042 | Lead acetate | U144 | 5000 |
| 302012 | Hydrazine | U133 | 1 |
| 303344 | Lasiocarpine | U143 | 10 |
| 305033 | Chlorambucil | U035 | 10 |
| 309002 | Aldrin | P004 | 1 |
| 311455 | Diethyl-p-nitrophenyl phosphate | P041 | 100 |
| 314409 | Bromacil | | 100 |
| 315184 | Mexacarbate | | 1000 |
| 316427 | "Emetine, dihydrochloride" | | 1 |
| 319846 | alpha-BHC | | 10 |
| 319857 | beta-BHC | | 1 |
| 319868 | delta-BHC | | 1 |
| 327980 | Trichloronate | | 1 |
| 329715 | "2,5-Dinitrophenol" | | 10 |
| 330541 | Diuron | | 100 |
| 330552 | Linuron | | 100 |
| 333415 | Diazinon | | 1 |
| 334883 | Diazomethane | | 100 |
| 353424 | Boron trifluoride compound with methyl ether (1:1) | | 1 |
| 353504 | Carbonic difluoride | U033 | 1000 |
| 357573 | Brucine | P018 | 100 |
| 359068 | Fluoroacetyl chloride | | 1 |
| 371620 | Ethylene fluorohydrin | | 1 |
| 379793 | Ergotamine tartrate | | 1 |
| 460195 | Cyanogen | P031 | 100 |
| 463581 | Carbonyl sulfide | | 100 |
| 465736 | Isodrin | P060 | 1 |
| 470906 | Chlorfenvinfos | | 1 |

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| 492808 | Auramine | U014 | 100 |
| 492808 | C.I. Solvent Yellow 34 | U014 | 100 |
| 494031 | Chlornaphazine | U026 | 100 |
| 496720 | Diaminotoluene | U221 | 10 |
| 502396 | Methylmercuric dicyanamide | | 1 |
| 504245 | 4-Aminopyridine | P008 | 1000 |
| 504245 | "Pyridine, 4-amino-" | P008 | 1000 |
| 504609 | "1,3-Pentadiene" | U186 | 100 |
| 505602 | Mustard gas | | 1 |
| 506616 | Potassium silver cyanide | P099 | 1 |
| 506649 | Silver cyanide | P104 | 1 |
| 506683 | Cyanogen bromide | U246 | 1000 |
| 506774 | Cyanogen chloride | P033 | 10 |
| 506785 | Cyanogen iodide | | 1 |
| 506876 | Ammonium carbonate | | 5000 |
| 506967 | Acetyl bromide | | 5000 |
| 509148 | Tetranitromethane | P112 | 10 |
| 510156 | Chlorobenzilate | U038 | 10 |
| 513495 | sec-Butylamine | | 1000 |
| 514738 | Dithiazanine iodide | | 1 |
| 528290 | o-Dinitrobenzene | | 100 |
| 532274 | 2-Chloroacetophenone | | 100 |
| 534076 | Bis(chloromethyl) ketone | | 1 |
| 534521 | Dinitrocresol | P047 | 10 |
| 534521 | "4,6-Dinitro-o-cresol" | P047 | 10 |
| 534521 | "4,6-Dinitro-o-cresol and salts" | P047 | 10 |
| 535897 | Crimidine | | 1 |
| 538078 | Ethylbis(2-chloroethyl)amine | | 1 |
| 540738 | "Hydrazine, 1,2-dimethyl-" | U099 | 1 |
| 540841 | "2,2,4-Trimethylpentane" | | 1000 |
| 540885 | tert-Butyl acetate | | 5000 |
| 541093 | Uranyl acetate | | 100 |
| 541253 | Lewisite | | 1 |
| 541537 | Dithiobiuret | P049 | 100 |
| 541731 | "1,3-Dichlorobenzene" | U071 | 100 |
| 542621 | Barium cyanide | P013 | 10 |
| 542756 | "1,3-Dichloropropene" | U084 | 1000 |
| 542756 | "1,3-Dichloropropylene" | U084 | 1000 |
| 542767 | 3-Chloropropionitrile | P027 | 1000 |
| 542767 | "Propionitrile, 3-chloro-" | P027 | 1000 |
| 542881 | Bis(chloromethyl) ether | P016 | 10 |
| 542881 | Chloromethyl ether | P016 | 10 |
| 542881 | Dichloromethyl ether | P016 | 10 |
| 542905 | Ethylthiocyanate | | 1 |
| 543908 | Cadmium acetate | | 10 |
| 544183 | Cobaltous formate | | 1000 |
| 544923 | Copper cyanide | P029 | 10 |
| 554847 | m-Nitrophenol | | 100 |
| 555771 | Tris(2-chloroethyl)amine | | 1 |
| 556616 | Methyl isothiocyanate | | 1 |
| 556649 | Methyl thiocyanate | | 1 |
| 557197 | Nickel cyanide | P074 | 10 |
| 557211 | Zinc cyanide | P121 | 10 |
| 557346 | Zinc acetate | | 1000 |
| 557415 | Zinc formate | | 1000 |
| 558258 | Methanesulfonyl fluoride | | 1 |

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| 563122 | Ethion | | 10 |
| 563417 | Semicarbazide hydrochloride | | 1 |
| 563688 | Thallium(I) acetate | U214 | 100 |
| 573568 | "2,6-Dinitrophenol" | | 10 |
| 584849 | "Toluene-2,4-diisocyanate" | | 100 |
| 591082 | 1-Acetyl-2-thiourea | P002 | 1000 |
| 592018 | Calcium cyanide | P021 | 10 |
| 592041 | Mercuric cyanide | | 1 |
| 592858 | Mercuric thiocyanate | | 10 |
| 592870 | Lead thiocyanate | | 100 |
| 593602 | Vinyl bromide | | 100 |
| 594423 | Perchloromethylmercaptan | | 100 |
| 594423 | Trichloromethanesulphenyl chloride | | 100 |
| 597648 | Tetraethyltin | | 1 |
| 598312 | Bromoacetone | P017 | 1000 |
| 606202 | "2,6-Dinitrotoluene" | U106 | 100 |
| 608935 | Pentachlorobenzene | U183 | 10 |
| 609198 | "3,4,5-Trichlorophenol" | | 10 |
| 610399 | "3,4-Dinitrotoluene" | | 10 |
| 614788 | "Thiourea, (2-methylphenyl)-" | | 1 |
| 615532 | N-Nitroso-N-methylurethane | U178 | 1 |
| 621647 | N-Nitrosodi-n-propylamine | U111 | 10 |
| 621647 | Di-n-propylnitrosamine | U111 | 10 |
| 624839 | Methyl isocyanate | P064 | 10 |
| 625161 | tert-Amyl acetate | | 5000 |
| 626380 | sec-Amyl acetate | | 5000 |
| 627112 | Chloroethyl chloroformate | | 1 |
| 628637 | Amyl acetate | | 5000 |
| 628864 | Mercury fulminate | P065 | 10 |
| 630104 | Selenourea | P103 | 1000 |
| 630206 | "Ethane, 1,1,1,2-tetrachloro-" | U208 | 100 |
| 630604 | Ouabain | | 1 |
| 631618 | Ammonium acetate | | 5000 |
| 636215 | o-Toluidine hydrochloride | U222 | 100 |
| 639587 | Triphenyltin chloride | | 1 |
| 640197 | Fluoroacetamide | P057 | 100 |
| 644644 | Dimetilan | | 1 |
| 675149 | Cyanuric fluoride | | 1 |
| 676971 | Methyl phosphonic dichloride | | 1 |
| 680319 | Hexamethylphosphoramide | | 1 |
| 684935 | N-Nitroso-N-methylurea | U177 | 1 |
| 692422 | Diethylarsine | P038 | 1 |
| 696286 | Dichlorophenylarsine | P036 | 1 |
| 696286 | Phenyl dichloroarsine | P036 | 1 |
| 732116 | Phosmet | | 1 |
| 757584 | Hexaethyl tetraphosphate | P062 | 100 |
| 759739 | N-Nitroso-N-ethylurea | U176 | 1 |
| 760930 | Methacrylic anhydride | | 1 |
| 764410 | "2-Butene, 1,4-dichloro-" | U074 | 1 |
| 765344 | Glycidylaldehyde | U126 | 10 |
| 786196 | Carbophenothion | | 1 |
| 814493 | Diethyl chlorophosphate | | 1 |
| 814686 | Acrylyl chloride | | 1 |
| 815827 | Cupric tartrate | | 100 |
| 822060 | "Hexamethylene-1,6-diisocyanate" | | 100 |
| 823405 | Diaminotoluene | U221 | 10 |

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|---------|-------------------------------|------|------|
| 824113 | Trimethylolpropane phosphite | | 1 |
| 900958 | "Stannane, acetoxetriphenyl-" | | 1 |
| 919868 | Demeton-S-methyl | | 1 |
| 920467 | Methacryloyl chloride | | 1 |
| 924163 | N-Nitrosodi-n-butylamine | U172 | 10 |
| 930552 | N-Nitrosopyrrolidine | U180 | 1 |
| 933755 | "2,3,6-Trichlorophenol" | | 10 |
| 933788 | "2,3,5-Trichlorophenol" | | 10 |
| 944229 | Fonofos | | 1 |
| 947024 | Phosfolan | | 1 |
| 950107 | Mephosfolan | | 1 |
| 950378 | Methidathion | | 1 |
| 959988 | alpha - Endosulfan | | 1 |
| 991424 | Norbormide | | 1 |
| 998301 | Triethoxysilane | | 1 |
| 999815 | Chlormequat chloride | | 1 |
| 1024573 | Heptachlor (and epoxide) | D031 | 1 |
| 1031078 | Endosulfan sulfate | | 1 |
| 1031476 | Triamiphos | | 1 |
| 1066304 | Chromic acetate | | 1000 |
| 1066337 | Ammonium bicarbonate | | 5000 |
| 1066451 | Trimethyltin chloride | | 1 |
| 1072351 | Lead stearate | | 5000 |
| 1111780 | Ammonium carbamate | | 5000 |
| 1116547 | N-Nitrosodiethanolamine | U173 | 1 |
| 1120714 | "1,3-Propane sultone" | U193 | 10 |
| 1120714 | Propane sultone | U193 | 10 |
| 1122607 | Nitrocyclohexane | | 1 |
| 1124330 | "Pyridine, 4-nitro-, 1-oxide" | | 1 |
| 1129415 | Metolcarb | | 1 |
| 1185575 | Ferric ammonium citrate | | 1000 |
| 1194656 | Dichlobenil | | 100 |
| 1300716 | Xylenol | | 1000 |
| 1303282 | Arsenic pentoxide | P011 | 1 |
| 1303328 | Arsenic disulfide | | 1 |
| 1303339 | Arsenic trisulfide | | 1 |
| 1306190 | Cadmium oxide | | 1 |
| 1309644 | Antimony trioxide | | 1000 |
| 1310583 | Potassium hydroxide | | 1000 |
| 1310732 | Sodium hydroxide | | 1000 |
| 1314325 | Thallic oxide | P113 | 100 |
| 1314563 | Phosphorus pentoxide | | 1 |
| 1314621 | Vanadium pentoxide | P120 | 1000 |
| 1314803 | Sulfur phosphide | U189 | 100 |
| 1314847 | Zinc phosphide (conc. > 10%) | P122 | 100 |
| 1314847 | Zinc phosphide | P122 | 100 |
| 1314847 | Zinc phosphide (conc. <= 10%) | U249 | 100 |
| 1314870 | Lead sulfide | | 5000 |
| 1319728 | "2,4,5-T amines" | | 5000 |
| 1319773 | Cresol (mixed isomers) | U052 | 100 |
| 1320189 | "2,4-D Esters" | | 100 |
| 1321126 | Nitrotoluene | | 1000 |
| 1327522 | Arsenic acid | P010 | 1 |
| 1327533 | Arsenic trioxide | P012 | 1 |
| 1327533 | Arsenous oxide | P012 | 1 |
| 1330207 | Xylene (mixed isomers) | U239 | 100 |

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|---------|--|------|------|
| 1332076 | Zinc borate | | 1000 |
| 1332214 | Asbestos (friable) | | 1 |
| 1333831 | Sodium bifluoride | | 100 |
| 1335326 | Lead subacetate | U146 | 100 |
| 1336216 | Ammonium hydroxide | | 1000 |
| 1336363 | PCBs | | 1 |
| 1336363 | Polychlorinated biphenyls | | 1 |
| 1338234 | Methyl ethyl ketone peroxide | U160 | 10 |
| 1338245 | Naphthenic acid | | 100 |
| 1341497 | Ammonium bifluoride | | 100 |
| 1397940 | Antimycin A | | 1 |
| 1420071 | Dinoterb | | 1 |
| 1464535 | "2,2'-Bioxirane" | U085 | 10 |
| 1464535 | Diepoxybutane | U085 | 10 |
| 1558254 | Trichloro(chloromethyl)silane | | 1 |
| 1563662 | Carbofuran | | 10 |
| 1582098 | Trifluralin | | 10 |
| 1600277 | Mercuric acetate | | 1 |
| 1615801 | "Hydrazine, 1,2-diethyl-" | U086 | 10 |
| 1622328 | "Ethanesulfonyl chloride, 2-chloro-" | | 1 |
| 1634044 | Methyl tert-butyl ether | | 1000 |
| 1642542 | Diethylcarbamazine citrate | | 1 |
| 1746016 | "2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)" | | 1 |
| 1752303 | Acetone thiosemicarbazide | | 1 |
| 1762954 | Ammonium thiocyanate | | 5000 |
| 1863634 | Ammonium benzoate | | 5000 |
| 1888717 | Hexachloropropene | U243 | 1000 |
| 1910425 | Paraquat | | 1 |
| 1918009 | Dicamba | | 1000 |
| 1928387 | "2,4-D Esters" | | 100 |
| 1928478 | "2,4,5-T esters" | | 1000 |
| 1928616 | "2,4-D Esters" | | 100 |
| 1929733 | "2,4-D Esters" | | 100 |
| 1982474 | Chloroxuron | | 1 |
| 2001958 | Valinomycin | | 1 |
| 2008460 | "2,4,5-T amines" | | 5000 |
| 2032657 | Mercaptodimethur | | 10 |
| 2032657 | Methiocarb | | 10 |
| 2074502 | Paraquat methosulfate | | 1 |
| 2097190 | Phenylsilatrane | | 1 |
| 2104645 | EPN | | 1 |
| 2223930 | Cadmium stearate | | 1 |
| 2231574 | Thiocarbazide | | 1 |
| 2238075 | Diglycidyl ether | | 1 |
| 2275185 | Prothoate | | 1 |
| 2303164 | Diallate | U062 | 100 |
| 2312358 | Propargite | | 10 |
| 2497076 | Oxydisulfoton | | 1 |
| 2524030 | Dimethyl phosphorochlorodithioate | | 1 |
| 2540821 | Formothion | | 1 |
| 2545597 | "2,4,5-T esters" | | 1000 |
| 2570265 | Pentadecylamine | | 1 |
| 2587908 | "Phosphorothioic acid, O,O-dimethyl-5-(2-(methylthio)ethyl)es" | | 1 |
| 2631370 | Promecarb | | 1 |
| 2636262 | Cyanophos | | 1 |
| 2642719 | Azinphos-ethyl | | 1 |

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|---------|--|------|------|
| 2665307 | "Phosphonothioic acid, methyl-, O-(4-nitrophenyl) O-phenyl es" | | 1 |
| 2703131 | "Phosphonothioic acid, methyl-, O-ethyl O-(4-(methylthio)phen" | | 1 |
| 2757188 | Thallous malonate | | 1 |
| 2763964 | 5-(Aminomethyl)-3-isoxazolol | P007 | 1000 |
| 2763964 | Muscimol | P007 | 1000 |
| 2764729 | Diquat | | 1000 |
| 2778043 | Endothion | | 1 |
| 2921882 | Chlorpyrifos | | 1 |
| 2944674 | Ferric ammonium oxalate | | 1000 |
| 2971382 | "2,4-D Esters" | | 100 |
| 3012655 | "Ammonium citrate, dibasic" | | 5000 |
| 3037727 | "Silane, (4-aminobutyl)diethoxymethyl-" | | 1 |
| 3164292 | Ammonium tartrate | | 5000 |
| 3165933 | "4-Chloro-o-toluidine, hydrochloride" | U049 | 100 |
| 3251238 | Cupric nitrate | | 100 |
| 3254635 | "Phosphoric acid, dimethyl 4-(methylthio) phenyl ester" | | 1 |
| 3288582 | "O,O-Diethyl S-methyl dithiophosphate" | U087 | 5000 |
| 3486359 | Zinc carbonate | | 1000 |
| 3547044 | DDE | | 1000 |
| 3569571 | "Sulfoxide, 3-chloropropyl octyl" | | 1 |
| 3615212 | "Benzimidazole, 4,5-dichloro-2-(trifluoromethyl)-" | | 1 |
| 3689245 | Sulfotep | P109 | 100 |
| 3689245 | Tetraethyldithiopyrophosphate | P109 | 100 |
| 3691358 | Chlorophacinone | | 1 |
| 3734972 | Amiton oxalate | | 1 |
| 3735237 | Methyl phenkapton | | 1 |
| 3813147 | "2,4,5-T amines" | | 5000 |
| 3878191 | Fuberidazole | | 1 |
| 4044659 | Bitoscanate | | 1 |
| 4098719 | Isophorone diisocyanate | | 1 |
| 4104147 | Phosacetim | | 1 |
| 4170303 | Crotonaldehyde | U053 | 100 |
| 4301502 | Fluenetil | | 1 |
| 4418660 | "Phenol, 2,2'-thiobis[4-chloro-6-methyl-" | | 1 |
| 4549400 | N-Nitrosomethylvinylamine | P084 | 10 |
| 4835114 | "Hexamethylenediamine, N,N'-dibutyl-" | | 1 |
| 5344821 | "Thiourea, (2-chlorophenyl)-" | P026 | 100 |
| 5836293 | Coumatetralyl | | 1 |
| 5893663 | Cupric oxalate | | 100 |
| 5972736 | Ammonium oxalate | | 5000 |
| 6009707 | Ammonium oxalate | | 5000 |
| 6369966 | "2,4,5-T amines" | | 5000 |
| 6369977 | "2,4,5-T amines" | | 5000 |
| 6533739 | Thallium(I) carbonate | U215 | 100 |
| 6533739 | Thallous carbonate | U215 | 100 |
| 6923224 | Monocrotophos | | 1 |
| 7005723 | 4-Chlorophenyl phenyl ether | | 5000 |
| 7421934 | Endrin aldehyde | | 1 |
| 7428480 | Lead stearate | | 5000 |
| 7439921 | Lead | D008 | 1 |
| 7439976 | Mercury | U151 | 1 |
| 7440020 | Nickel | | 100 |
| 7440224 | Silver | D011 | 1000 |
| 7440235 | Sodium | | 10 |
| 7440280 | Thallium | | 1000 |
| 7440360 | Antimony | | 5000 |

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|---------|------------------------------|------|------|
| 7440382 | Arsenic | D004 | 1 |
| 7440417 | Beryllium | P015 | 10 |
| 7440439 | Cadmium | D006 | 10 |
| 7440473 | Chromium | | 5000 |
| 7440508 | Copper | | 5000 |
| 7440666 | Zinc (fume or dust) | | 1000 |
| 7440666 | Zinc | | 1000 |
| 7446084 | Selenium dioxide | | 10 |
| 7446095 | Sulfur dioxide | | 1 |
| 7446119 | Sulfur trioxide | | 1 |
| 7446142 | Lead sulfate | | 100 |
| 7446186 | Thallium(I) sulfate | P115 | 100 |
| 7446186 | Thallous sulfate | P115 | 100 |
| 7446277 | Lead phosphate | U145 | 1 |
| 7447394 | Cupric chloride | | 10 |
| 7487947 | Mercuric chloride | | 1 |
| 7488564 | Selenium sulfide | U205 | 10 |
| 7550450 | Titanium tetrachloride | | 100 |
| 7558794 | "Sodium phosphate, dibasic" | | 5000 |
| 7580678 | Lithium hydride | | 1 |
| 7601549 | "Sodium phosphate, tribasic" | | 5000 |
| 7631892 | Sodium arsenate | | 1? |
| 7631905 | Sodium bisulfite | | 5000 |
| 7632000 | Sodium nitrite | | 100 |
| 7632707 | Boron trifluoride | | |

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|---------|---|------|------|
| 7775113 | Sodium chromate | | 10 |
| 7778394 | Arsenic acid | P010 | 1 |
| 7778441 | Calcium arsenate | | 1 |
| 7778509 | Potassium bichromate | | 10 |
| 7778543 | Calcium hypochlorite | | 10 |
| 7779864 | Zinc hydrosulfite | | 1000 |
| 7779886 | Zinc nitrate | | 1000 |
| 7782414 | Fluorine | P056 | 10 |
| 7782492 | Selenium | D010 | 100 |
| 7782505 | Chlorine | | 10 |
| 7782630 | Ferrous sulfate | | 1000 |
| 7782823 | Sodium selenite | | 100 |
| 7782867 | Mercurous nitrate | | 10 |
| 7783008 | Selenious acid | U204 | 10 |
| 7783064 | Hydrogen sulfide | U135 | 100 |
| 7783075 | Hydrogen selenide | | 1 |
| 7783359 | Mercuric sulfate | | 10 |
| 7783462 | Lead fluoride | | 100 |
| 7783495 | Zinc fluoride | | 1000 |
| 7783508 | Ferric fluoride | | 100 |
| 7783564 | Antimony trifluoride | | 1000 |
| 7783600 | Sulfur tetrafluoride | | 1 |
| 7783702 | Antimony pentafluoride | | 1 |
| 7783804 | Tellurium hexafluoride | | 1 |
| 7784341 | Arsenous trichloride | | 1 |
| 7784409 | Lead arsenate | | 1 |
| 7784410 | Potassium arsenate | | 1 |
| 7784421 | Arsine | | 1 |
| 7784465 | Sodium arsenite | | 1 |
| 7785844 | "Sodium phosphate, tribasic" | | 5000 |
| 7786347 | Mevinphos | | 10 |
| 7786814 | Nickel sulfate | | 100 |
| 7787475 | Beryllium chloride | | 1 |
| 7787497 | Beryllium fluoride | | 1 |
| 7787555 | Beryllium nitrate | | 1 |
| 7788989 | Ammonium chromate | | 10 |
| 7789006 | Potassium chromate | | 10 |
| 7789062 | Strontium chromate | | 10 |
| 7789095 | Ammonium bichromate | | 10 |
| 7789426 | Cadmium bromide | | 10 |
| 7789437 | Cobaltous bromide | | 1000 |
| 7789619 | Antimony tribromide | | 1000 |
| 7790945 | Chlorosulfonic acid | | 1000 |
| 7791120 | Thallium chloride TlCl | U216 | 100 |
| 7791120 | Thallous chloride | U216 | 100 |
| 7791233 | Selenium oxychloride | | 1 |
| 7803512 | Phosphine | P096 | 100 |
| 7803556 | Ammonium vanadate | P119 | 1000 |
| 8001352 | Campechlor | P123 | 1 |
| 8001352 | "Camphene, octachloro-" | P123 | 1 |
| 8001352 | Toxaphene | P123 | 1 |
| 8001589 | Creosote | U051 | 1 |
| 8003198 | Dichloropropane - Dichloropropene (mixture) | | 100 |
| 8003347 | Pyrethrins | | 1 |
| 8014957 | Sulfuric acid (fuming) | | 1000 |
| 8065483 | Demeton | | 1 |

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| 10022705 | Sodium hypochlorite | | 100 |
| 10025737 | Chromic chloride | | 1 |
| 10025873 | Phosphorus oxychloride | | 1000 |
| 10025919 | Antimony trichloride | | 1000 |
| 10026116 | Zirconium tetrachloride | | 5000 |
| 10026138 | Phosphorus pentachloride | | 1 |
| 10028156 | Ozone | | 1 |
| 10028225 | Ferric sulfate | | 1000 |
| 10031591 | Thallium sulfate | | 100 |
| 10039324 | "Sodium phosphate, dibasic" | | 5000 |
| 10043013 | Aluminum sulfate | | 5000 |
| 10045893 | Ferrous ammonium sulfate | | 1000 |
| 10045940 | Mercuric nitrate | | 10 |
| 10049055 | Chromous chloride | | 1000 |
| 10099748 | Lead nitrate | | 100 |
| 10101538 | Chromic sulfate | | 1000 |
| 10101630 | Lead iodide | | 100 |
| 10101890 | "Sodium phosphate, tribasic" | | 5000 |
| 10102064 | Uranyl nitrate | | 100 |
| 10102188 | Sodium selenite | | 100 |
| 10102202 | Sodium tellurite | | 1 |
| 10102439 | Nitric oxide | P076 | 10 |
| 10102440 | Nitrogen dioxide | P078 | 10 |
| 10102451 | Thallium(I) nitrate | U217 | 100 |
| 10102484 | Lead arsenate | | 1 |
| 10108642 | Cadmium chloride | | 10 |
| 10124502 | Potassium arsenite | | 1 |
| 10124568 | "Sodium phosphate, tribasic" | | 5000 |
| 10140655 | "Sodium phosphate, dibasic" | | 5000 |
| 10140871 | "Ethanol, 1,2-dichloro-, acetate" | | 1 |
| 10192300 | Ammonium bisulfite | | 5000 |
| 10196040 | Ammonium sulfite | | 5000 |
| 10210681 | Cobalt carbonyl | | 1 |
| 10265926 | Methamidophos | | 1 |
| 10294345 | Boron trichloride | | 1 |
| 10311849 | Dialifor | | 1 |
| 10361894 | "Sodium phosphate, tribasic" | | 5000 |
| 10380297 | "Cupric sulfate, ammoniated" | | 100 |
| 10415755 | Mercurous nitrate | | 10 |
| 10421484 | Ferric nitrate | | 1000 |
| 10476956 | Methacrolein diacetate | | 1 |
| 10544726 | Nitrogen dioxide | | 10 |
| 10588019 | Sodium bichromate | | 10 |
| 11096825 | Aroclor 1260 | | 1 |
| 11097691 | Aroclor 1254 | | 1 |
| 11104282 | Aroclor 1221 | | 1 |
| 11115745 | Chromic acid | | 10 |
| 11141165 | Aroclor 1232 | | 1 |
| 12002038 | Cupric acetoarsenite | | 1 |
| 12002038 | Paris green | | 1 |
| 12039520 | "Selenious acid, dithallium(1+) salt" | P114 | 1000 |
| 12054487 | Nickel hydroxide | | 10 |
| 12108133 | "Manganese, tricarbonyl methylcyclopentadienyl" | | 1 |
| 12125018 | Ammonium fluoride | | 100 |
| 12125029 | Ammonium chloride | | 5000 |
| 12135761 | Ammonium sulfide | | 100 |

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| 12672296 | Aroclor 1248 | | 1 |
| 12674112 | Aroclor 1016 | | 1 |
| 12771083 | Sulfur monochloride | | 1000 |
| 13071799 | Terbufos | | 1 |
| 13171216 | Phosphamidon | | 1 |
| 13194484 | Ethoprophos | | 1 |
| 13410010 | Sodium selenate | | 1 |
| 13450903 | Gallium trichloride | | 1 |
| 13463393 | Nickel carbonyl | P073 | 10 |
| 13463406 | "Iron, pentacarbonyl-" | | 1 |
| 13494809 | Tellurium | | 1 |
| 13560991 | "2,4,5-T salts" | | 1000 |
| 13597994 | Beryllium nitrate | | 1 |
| 13746899 | Zirconium nitrate | | 5000 |
| 13765190 | Calcium chromate | U032 | 10 |
| 13814965 | Lead fluoborate | | 100 |
| 13826830 | Ammonium fluoborate | | 5000 |
| 13952846 | sec-Butylamine | | 1000 |
| 14017415 | Cobaltous sulfamate | | 1000 |
| 14167181 | Salcomine | | 1 |
| 14216752 | Nickel nitrate | | 100 |
| 14258492 | Ammonium oxalate | | 5000 |
| 14307358 | Lithium chromate | | 10 |
| 14307438 | Ammonium tartrate | | 5000 |
| 14639975 | Zinc ammonium chloride | | 1000 |
| 14639986 | Zinc ammonium chloride | | 1000 |
| 14644612 | Zirconium sulfate | | 5000 |
| 15271417 | "Bicyclo[2.2.1]heptane-2-carbonitrile, 5-chloro-6-(((methyla" | | 1 |
| 15699180 | Nickel ammonium sulfate | | 100 |
| 15739807 | Lead sulfate | | 100 |
| 15950660 | "2,3,4-Trichlorophenol" | | 10 |
| 16721805 | Sodium hydrosulfide | | 5000 |
| 16752775 | "Ethanimidothioic acid, N-[[methylamino)carbonyl]" | P066 | 100 |
| 16752775 | Methomyl | P066 | 100 |
| 16871719 | Zinc silicofluoride | | 5000 |
| 16919190 | Ammonium silicofluoride | | 1000 |
| 16923958 | Zirconium potassium fluoride | | 1000 |
| 17702419 | Decaborane(14) | | 1 |
| 17702577 | Formparanate | | 1 |
| 18883664 | "D-Glucose, 2-deoxy-2-[[[(methylnitrosoamino)-carbo" | U206 | 1 |
| 19287457 | Diborane | | 1 |
| 19624227 | Pentaborane | | 1 |
| 20816120 | Osmium oxide OsO4 (T-4)- | P087 | 1000 |
| 20816120 | Osmium tetroxide | P087 | 1000 |
| 20830755 | Digoxin | | 1 |
| 20830813 | Daunomycin | U059 | 10 |
| 20859738 | Aluminum phosphide | P006 | 100 |
| 21548323 | Fosthietan | | 1 |
| 21609905 | Leptophos | | 1 |
| 21908532 | Mercuric oxide | | 1 |
| 21923239 | Chlorthiophos | | 1 |
| 22224926 | Fenamiphos | | 1 |
| 23135220 | Oxamyl | | 1 |
| 23422539 | Formetanate hydrochloride | | 1 |
| 23505411 | Pirimifos-ethyl | | 1 |
| 23950585 | "Benzamide,3,5-dichloro-N-(1,1-dimethyl-2-propynyl" | U192 | 5000 |

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| 24017478 | Triazofos | | 1 |
| 24934916 | Chlormephos | | 1 |
| 25154545 | Dinitrobenzene (mixed isomers) | | 100 |
| 25154556 | Nitrophenol (mixed isomers) | | 100 |
| 25155300 | Sodium dodecylbenzenesulfonate | | 1000 |
| 25167822 | Trichlorophenol | | 10 |
| 25168154 | "2,4,5-T esters" | | 1000 |
| 25168267 | "2,4-D Esters" | | 100 |
| 25321146 | Dinitrotoluene (mixed isomers) | | 10 |
| 25321226 | Dichlorobenzene | | 100 |
| 25321226 | Dichlorobenzene (mixed isomers) | | 100 |
| 25376458 | Diaminotoluene (mixed isomers) | U221 | 10 |
| 25376458 | Toluenediamine | U221 | 10 |
| 25550587 | Dinitrophenol | | 10 |
| 26264062 | Calcium dodecylbenzenesulfonate | | 1000 |
| 26419738 | "Carbamic acid, methyl-, O-(((2,4-dimethyl-1, 3-dithiolan-2-y" | | 1 |
| 26471625 | Toluenediisocyanate (mixed isomers) | U223 | 100 |
| 26628228 | Sodium azide (Na(N3)) | P105 | 1000 |
| 26638197 | Dichloropropane | | 1000 |
| 26952238 | Dichloropropene | | 100 |
| 27137855 | Trichloro(dichlorophenyl)silane | | 1 |
| 27176870 | Dodecylbenzenesulfonic acid | | 1000 |
| 27323417 | Triethanolamine dodecylbenzene sulfonate | | 1000 |
| 27774136 | Vanadyl sulfate | | 1000 |
| 28300745 | Antimony potassium tartrate | | 100 |
| 28347139 | Xylylene dichloride | | 1 |
| 28772567 | Bromadiolone | | 1 |
| 30525894 | Paraformaldehyde | | 1000 |
| 30674807 | Methacryloyloxyethyl isocyanate | | 1 |
| 32534955 | "2,4,5-TP esters" | | 100 |
| 33213659 | beta - Endosulfan | | 1 |
| 36478769 | Uranyl nitrate | | 100 |
| 37211055 | Nickel chloride | | 100 |
| 39196184 | Thiofanox | P045 | 100 |
| 42504461 | Isopropanolamine dodecylbenzene sulfonate | | 1000 |
| 50782699 | "Phosphonothioic acid, methyl-, S-(2-(bis(1-methylethyl)amino" | | 1 |
| 52628258 | Zinc ammonium chloride | | 1000 |
| 52652592 | Lead stearate | | 5000 |
| 52740166 | Calcium arsenite | | 1 |
| 53467111 | "2,4-D Esters" | | 100 |
| 53469219 | Aroclor 1242 | | 1 |
| 53558251 | Pyriminil | | 1 |
| 55488874 | Ferric ammonium oxalate | | 1000 |
| 56189094 | Lead stearate | | 5000 |
| 58270089 | "Zinc, dichloro(4,4-dimethyl-5((((methylamino)carbonyl)oxy)im" | | 1 |
| 61792072 | "2,4,5-T esters" | | 1000 |
| 62207765 | "Cobalt, ((2,2'-(1,2-ethanediylbis(nitrilomethylidyne))bis(6-" | | 1 |
| | Radionuclides (including radon) | | App. B |
| | Multi Source Leachate | | 1 |
| | Unlisted hazardous wastes characteristic of ignitability | D001 | 100 |
| | Unlisted hazardous wastes characteristic of corrosivity | D002 | 100 |
| | Unlisted hazardous wastes characteristic of reactivity | D003 | 100 |
| | Spent Halogenated Solvents used in Degreasing | F001 | 10 |
| | Spent halogenated solvents: | F002 | 10 |
| | Spent non-halogenated solvents: | F003 | 100 |
| | Spent non-halogenated solvents and still bttm. from | | |

| | | |
|---|--|-----|
| cresol/nitrobenzene recovery | F004 | 100 |
| Spent non-halogenated solvents(still bttm.) toluene\methyl ethyl ketone recovery | F005 | 100 |
| Wastewater treatment sludges from electroplating operations | F006 | 10 |
| Spent cyanide plating bath solns. from electroplating | F007 | 10 |
| Plating bath residues from electroplating where cyanides are used | F008 | 10 |
| Spent stripping/cleaning bath solns. from electroplating where cyanides are used | F009 | 10 |
| Quenching bath residues from metal heat treating where cyanides are used | F010 | 10 |
| Spent cyanide soln. from salt bath pot cleaning from metal heat treating | F011 | 10 |
| Quenching wastewater sludges from metal heat treating where cyanides are used | F012 | 10 |
| Wastewater treatment sludges from chemical conversion of aluminum coating | F019 | 10 |
| Wastes from prod. or use of tri/tetrachlorophenol or derivatives | F020 | 1 |
| Wastes from prod. or use of pentachlorophenol or intermediates | F021 | 1 |
| Wastes from use of tetra/penta/hexachlorobenzenes | F022 | 1 |
| Wastes from mat. prod. on equip. which prev. used tri/tetrachlorophenol | F023 | 1 |
| Wastes from prod. of chlorinated aliphatic hydrocarbons (C1-C5) | F024 | 1 |
| "Lights ends, filters from prod. of chlorinated aliphatic hydrocarbons(C1-C5)" | F025 | 1 |
| Waste from equipment previously used to prod. tetra/penta/hexachlorobenzenes | F026 | 1 |
| Discarded wastes containing tetra/penta/hexachlorobenzenes or derivatives | F027 | 1 |
| "Residues from incineration of contaminated soils: | F020,F021, F022,F023, F026,F027" | 1 |
| "Wastewaters, process residuals from wood preserving using chlorophenolic solns." | F032 | 1 |
| "Wastewaters, process residuals from wood preserving using creosote formulations" | F034 | 1 |
| "Wastewaters, process residuals from wood preserving using arsenic or chromium" | F035 | 1 |
| Petroleum refinery primary oil/water/solids separation sludge | F037 | 1 |
| Petroleum refinery secondary (emulsified) oil/water/solids separation sludge | F038 | 1 |
| F069 | F069 | 10 |
| Wastewater treatment sludge from creosote or pentachlorophenol wood preserving | K001 | 1 |
| Wastewater treatment sludge from prod. of chrome yellow and orange pigments | K002 | 1 |
| Wastewater treatment sludge from prod. of molybdate orange pigments | K003 | 1 |
| Wastewater treatment sludge from prod. of zinc yellow pigments | K004 | 10 |
| Wastewater treatment sludge from prod. of chrome green pigments | K005 | 1 |
| Wastewater treatment sludge from prod. of chrome oxide green pigments anhydrous | K006 | 10 |
| Wastewater treatment sludge from prod. of iron blue pigments | K007 | 10 |

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| Oven residue from prod. of chrome oxide green pigments | K008 | 10 |
| Dist. bottoms from prod. of acetaldehyde from ethylene | K009 | 10 |
| Dist. side cuts from prod. of acetaldehyde from ethylene | K010 | 10 |
| Bottom stream from wastewater stripper in acrylonitrile prod. | K011 | 10 |
| Bottom stream from acetonitrile column in acrylonitrile prod. | K013 | 10 |
| Bottoms from acetonitrile purification column in acrylonitrile prod. | K014 | 5000 |
| Still bottoms from the dist. of benzyl chloride | K015 | 10 |
| Heavy ends or dist. residues from prod. of carbon tetrachloride | K016 | 1 |
| Heavy ends from the purification column in epichlorohydrin prod. | K017 | 10 |
| Heavy ends from the fractionation column in ethyl chloride prod. | K018 | 1 |
| Heavy ends from the dist. of ethylene dichloride during its prod. | K019 | 1 |
| Heavy ends from the dist. of vinyl chloride during prod. of the monomer | K020 | 1 |
| Aqueous spent antimony catalyst waste from fluoromethanes prod. | K021 | 10 |
| Dist. bottom tars from prod. of phenol/acetone from cumene | K022 | 1 |
| Dist. light ends from prod. of phthalic anhydride from naphthalene | K023 | 5000 |
| Dist. bottoms from prod. of phthalic anhydride from naphthalene | K024 | 5000 |
| Dist. bottoms from prod. of nitrobenzene by nitration of benzene | K025 | 10 |
| Stripping still tails from the prod. of methyl ethyl pyridines | K026 | 1000 |
| Centrifuge/dist. residues from toluene diisocyanate prod. | K027 | 10 |
| "Spent catalyst from hydrochlorinator reactor in prod. of 1,1,1-trichloroethane" | K028 | 1 |
| "Waste from product steam stripper in prod. of 1,1,1-trichloroethane" | K029 | 1 |
| Column bottoms(heavy ends) from prod. of trichloroethylene and perchloroethylene | K030 | 1 |
| By-product salts generated in the prod. msma and cacodylic acid | K031 | 1 |
| Wastewater treatment sludge from the prod. of chlordane | K032 | 10 |
| Wastewater/scrubwater from chlorination during prod. of chlordane | K033 | 10 |
| Filter solids from filtration of hexachlorocyclopentadiene in chlordane prod. | K034 | 10 |
| Wastewater treatment sludges from the prod. of creosote | K035 | 1 |
| Still bottoms from toluene reclamation distillation in disulfoton prod. | K036 | 1 |
| Wastewater treatment sludges from the prod. of disulfoton | K037 | 1 |
| Wastewater from the washing and stripping of phorate production | K038 | 10 |
| Filter cake from filtration during prod. of phorate | K039 | 10 |
| Wastewater treatment sludge from the prod. of phorate | K040 | 10 |
| Wastewater treatment sludge from the prod. of toxaphene | K041 | 1 |
| "Heavy ends from dist. of tetrachlorobenzene in the prod. of 2,4,5-T" | K042 | 10 |
| "2,6-Dichlorophenol waste from the prod. of 2,4-D" | K043 | 10 |
| Wastewater treatment sludge from manuf. and processing of explosives | K044 | 10 |
| Spent carbon from treatment of wastewater containing explosives | K045 | 10 |
| "Wastewater sludge from manuf.,formulating,loading of lead-based initiating compd" | K046 | 100 |
| Pink/red water from TNT operations | K047 | 10 |
| Dissolved air flotation (DAF) float from the petroleum refining industry | K048 | 1 |
| Slop oil emulsion solids from the petroleum refining industry | K049 | 1 |
| Heat exchanger bundle cleaning sludge from petroleum refining industry | K050 | 10 |

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| API separator sludge from the petroleum refining industry | K051 | 1 |
| Tank bottoms (leaded) from the petroleum refining industry | K052 | 10 |
| Ammonia still lime sludge from coking operations | K060 | 1 |
| Emission control dust/sludge from primary prod. of steel in electric furnaces | K061 | 1 |
| Spent pickle liquor generated by steel finishing: (SIC codes 331 and 332) | K062 | 1 |
| Acid plant blowdown sludge from blowdown slurry from primary copper prod. | K064 | 1 |
| Surface impoundment solids at primary lead smelting facilities | K065 | 1 |
| Sludge from treatment of wastewater(acid plant blowdown) from primary zinc prod. | K066 | 1 |
| Emission Control Dust/Sludge from secondary lead smelting | K069 | 1 |
| Brine purification muds from mercury cell process in chlorine production | K071 | 1 |
| Chlorinated hydrocarbon waste in chlorine production | K073 | 10 |
| Distillation bottoms from aniline extraction | K083 | 100 |
| Wastewater sludges from prod. of veterinary pharm. from arsenic compds. | K084 | 1 |
| Distillation or fractionation column bottoms in prod. of chlorobenzenes | K085 | 10 |
| Wastes/sludges from prod. of inks from chromium and lead compds. | K086 | 1 |
| Decanter tank tar sludge from coking operations | K087 | 100 |
| Spent potliners from primary aluminum reduction | K088 | 10 |
| Emission control dust/sludge from ferrochromiumsilicon prod. | K090 | 10 |
| Emission control dust/sludge from ferrochromium prod. | K091 | 10 |
| Dist. light ends from prod. of phthalic anhydride by ortho-xylene | K093 | 5000 |
| Dist. bottoms in prod. of phthalic anhydride by ortho-xylene | K094 | 5000 |
| "Distillation bottoms in prod. of 1,1,1-trichloroethane" | K095 | 100 |
| "Heavy ends from dist. column in prod. of 1,1,1-trichloroethane" | K096 | 100 |
| Vacuum stripper discharge from the chlordane chlorinator in prod. of chlordane | K097 | 1 |
| Untreated process wastewater from the prod. of toxaphene | K098 | 1 |
| "Untreated wastewater from the prod. of 2,4-D" | K099 | 10 |
| Waste leaching soln. from acid leaching of emission dust in 2nd lead smelting | K100 | 1 |
| Dist. tar residue from aniline in prod. of veterinary pharm. from arsenic compd. | K101 | 1 |
| Residue from activated carbon in prod. of veterinary pharm. from arsenic compds. | K102 | 1 |
| Process residues from aniline extraction from the prod. of aniline | K103 | 100 |
| Combined wastewater streams generated from prod. of nitrobenzene/aniline | K104 | 10 |
| Aqueous stream from washing in prod. of chlorobenzenes | K105 | 10 |
| Wastewater treatment sludge from mercury cell process in chlorine prod. | K106 | 1 |
| Column bottoms from separation in prod. of UDMH from carboxylic acid hydrazides | K107 | 10 |
| Condensed column overheads and vent gas from prod. of UDMH from -COOH hydrazides | K108 | 10 |
| Spent filter catridges from purif. of UDMH prod. from carboxylic acid hydrazides | K109 | 10 |
| Condensed column overheads from prod. of UDMH from carboxylic acid hydrazides | K110 | 10 |
| Product washwaters from prod. of dinitrotoluene via nitration of | | |

| | | |
|--|------|------|
| benzene | K111 | 10 |
| Reaction by-product water from drying of toluenediamine during its prod. | K112 | 10 |
| Condensed liquid light ends from purification of toluenediamine during its prod. | K113 | 10 |
| Vicinals from purification of toluenediamine during its prod. | K114 | 10 |
| Heavy ends from purification of toluenediamine during its prod. | K115 | 10 |
| Organic condensate solvent recovery system in prod. of toluene diisocyanate | K116 | 10 |
| Wastewater from vent gas scrubber in prod. of ethylene bromide prod. from ethene | K117 | 1 |
| Spent absorbant solids in purification of ethylene dibromide manuf. from ethene | K118 | 1 |
| K119 | K119 | 100 |
| K120 | K120 | 100 |
| K121 | K121 | 100 |
| Process waterwater from the prod. of ethylenebisdithiocarbamic acid and salts | K123 | 10 |
| Reactor vent scubber water from prod of ethylenebisdithiocarbamic acid and salts | K124 | 10 |
| Solids formed in the prod. of ethylenebisdithiocarbamic acid and salts | K125 | 10 |
| Dust/sweepings from the prod. of ethylenebisdithiocarbamic acid and salts | K126 | 10 |
| Wastewater and spent sulfuric acid from the prod. of methyl bromide | K131 | 100 |
| Spent absorbent and waste water from the prod. of methyl bromide | K132 | 1000 |
| Still bottoms from purification of ethylene dibromide manuf. from ethene | K136 | 1 |
| K141 | K141 | 1 |
| K142 | K142 | 1 |
| K143 | K143 | 1 |
| K144 | K144 | 1 |
| K145 | K145 | 1 |
| K147 | K147 | 1 |
| K148 | K148 | 1 |
| Distillation bottoms from the production of chlorinated toluenes | K149 | 10 |
| Organic residuals of Cl gas and HCl from production of chlorinated toluenes | K150 | 10 |
| Wastewater treatment sludge from production of chlorinated toluenes | K151 | 10 |

RQ is in pounds.

* Indicates that the EPA was considering several options for the CERCLA reporting requirements that would apply to these broad generic categories of hazardous air pollutants.

** Indicates that no RQ is being assigned to the generic or broad class

App B refers to Appendix B of Section 302.4 as it appears in the CFR published on July 1, 1993.

Section 2

Appendix 2B

HSERC Listings

Hawaii State Department of Health Hazard Evaluation and Emergency Response Office (HEER) Hazardous Substance Release Notification and Inventory Guideline

Emergency Planning and Community Right to Know Act of 1986 §302, §304, §311, §312 and §313
Hawaii Emergency Planning and Community Right to Know Act §128E-6, §128E-7, §128E-9
The State Contingency Plan, Title 11 Chapter 451 Hawaii Administrative Rules §11-451-7
Comprehensive Environmental Response Compensation and Liability Act §103

The Hawaii State Emergency Response Commission (HSERC), the Local Emergency Planning Committee (LEPC), local Fire Department and the National Response Center (NRC) must receive the appropriate notification upon a covered chemical release and/or for routine inventories at the addresses and phone numbers listed in the table below.

| County | HSERC | LEPC | Fire Department | NRC |
|----------------------|--|---|---|-------------------------|
| Hawaii | Hawaii State Department of Health 919 Ala Moana Blvd., Rm 206 Honolulu, Hawaii 96814-4912 Attn: EPCRA Data Manager Phone (808) 586-4249 After Hours (808)247-2191 Fax (808) 586-7537 | Jay Sasan Industrial Safety Office 25 Aupuni St. Hilo, Hawaii 96720 Phone 961-8215 After Hours 935-3311 Fax 961-8248 | Nelson Tsuji, Chief Hawaii County Fire Dept. 466 Kinooole St. Hilo, Hawaii 96720 Phone 961-8336 After Hours 911 | 1(800)424-8802 |
| C & C of Honolulu | Hawaii State Department of Health Same address and phone numbers statewide. | Leland Nakai Oahu Civil Defense 650 South King St. Honolulu, Hawaii 96813 Phone 523-4121 After Hours 911 Fax 524-3439 | Anthony Lopez, Chief Honolulu Fire Dept. 3375 Koapaka St., Ste H425 Honolulu, Hawaii 96814 Phone 831-7771 After Hours 911 | Same number nationwide. |
| Kauai | Hawaii State Department of Health Same address and phone numbers statewide. | Clifford Ikeda Kauai Civil Defense 4396 Rice St., Rm 107 Lihue, Hawaii 96766 Phone 241-6336 After Hours 241-6711 Fax 241-6335 | David Sproat, Chief Kauai Fire Department 4444 Rice St., Suite 295 Lihue, Hawaii 96766 Phone 241-6500 After Hours 241-6711 | Same number nationwide. |
| Maui | Hawaii State Department of Health Same address and phone numbers statewide. | Joseph Blackburn, Captain Maui Fire Dept. 200 Dairy Rd. Kahului, Hawaii 96732 Phone 243-7561 After Hours 911 Fax 242-4479 | Ronald Davis Maui Fire Dept. 200 Dairy Rd. Kahului, Hawaii 96732 Phone 243-7561 After Hours 911 | Same number nationwide. |

HEER Hazardous Substance Release Notification and Inventory Guideline - Summary Implementation Table

| Statute or Regulation Section Number | List of Lists(7/1/93) Column Heading | Who must Provide Information | Information to Provide | To Whom Information Goes | When to Submit Information |
|---------------------------------------|--|--|--|------------------------------|--|
| \$302 §128E-6 | Sec. 302 (EHS) TPQ | All who store in excess of the TPQ. | Letter stating that you are regulated. | HSERC, LEPC | Information due within 60 days of receipt of Extremely Hazardous Substance at a facility. |
| \$304 §128E-7 §11-451-7 §103 | EHS RQ CERCLA RQ and 10 pound RQ for TCP and Oil under the listed circumstances.* | Those who release above the RQ. | Release Notification and Written Follow-up. | HSERC, LEPC | Release Notification due immediately. Written follow-up due as soon as possible within 30 days. |
| \$103 | CERCLA RQ | Those who release above the RQ. | Release Notification | NRC | Immediately. |
| \$311 §128E-6(2)(A) | Sec. 302 (EHS) TPQ and 10,000 pound TPQ for OSHA Hazardous Chemicals. | Those who store above the TPQ. | List of MSDS Chemicals and Hazard Categories for Each. | HSERC, LEPC, Fire Department | Due annually by March 1 for preceding calendar year inventory. |
| \$312 §128E-6(2)(B)&(C) | Sec. 302 (EHS) TPQ and 10,000 pound TPQ for OSHA Hazardous Chemicals. | Those who store above the TPQ. | Hawaii Chemical Inventory Form (Tier II) and Site Map. | HSERC, LEPC, Fire Department | Due annually by March 1 for preceding calendar year inventory. |
| \$128E-9 | | Those who submit an HCIF. | Filing Fee - \$100 per facility. | HSERC | Due annually with HCIF. |
| \$313 | Sec 313 | Manufacturing facilities in SIC Codes 20-39, with more than 10 employees, which manufacture more than 10,000 pounds or process or otherwise use more than 25,000 pounds of the listed chemicals. | TRI Form R | | Due annually by July 1 for preceding calendar year inventory. |

*(A) Any amount of oil which when released into the environment causes a sheen to appear on surface water, or any navigable water of the State;
 (B) Any free product that appears on ground water;
 (C) Any amount of oil released to the environment greater than 25 gallons; and
 (D) Any amount of oil released to the environment which is less than 25 gallons, but which is not contained and remediated within 72 hours.

Section 2

Appendix 2C

Hazardous Substance Inventory Guidelines

**Hawaii State Department of Health
Hazard Evaluation and Emergency Response Office (HEER)
Hazardous Substance Release Notification Guideline**

Overview of Requirements

In Hawaii, owners and operators of facilities or vessels reporting covered releases of hazardous substances are subject to state notification requirements under the Hawaii Emergency Planning and Community Right-to-Know Act (HEPCRA) and Title 11, Chapter 451, Hawaii Administrative Rules, the State Contingency Plan (SCP).

Pursuant to the requirements of the State Contingency Plan, the owner or operator of a facility or vessel must immediately notify the Hawaii State Emergency Response Commission (HSERC)/HEER (586-4249 or 247-2191 after work hours) and the Local Emergency Planning Committee (LEPC) of the appropriate jurisdiction after the release of:

- 1) a listed hazardous substance designated under section 11-451-5(b), in quantities equal to or exceeding the reportable quantity criteria in section 11-451-6(b) in any 24-hour period;
- 2) or an unlisted hazardous substance designated under section 11-451-5(c), in quantities equal to or exceeding the reportable quantity criteria in section 11-451-6(c) in any 24-hour period.

Note: HSERC/HEER are listed together because the Hawaii State Department of Health Hazard Evaluation and Emergency Response Office is the administrative contact for the Hawaii State Emergency Response Commission.

An exception from immediate notification is provided for releases of oil of less than 25 gallons in any 24-hour period which is not contained and remedied within 72-hours. Such releases must be reported in written form only within 30 days of the discovery of the release.

In the case of a release that occurs "with respect to transportation of a substance", dialing 911 or contacting the operator and reporting such a release will satisfy the initial emergency notification requirements. The owner or operator of the facility or vessel must also provide a written follow-up notice. If a release of a hazardous substance poses an imminent or immediate threat to public health or the environment, dial 911 to request fire, police, or emergency medical service personnel response.

Immediate Notification Contents

Immediate verbal notification to the department and LEPC shall consist of providing the following information to the extent known at the time of the notice so long as no delay in responding to the emergency results. (Do not delay due to incomplete notification information related to the release.)

- (1) The name (trade and chemical) and chemical abstract service registry number, if available, of the hazardous substance which has been released;
- (2) The approximate quantity of the hazardous substance, pollutant, or contaminant which has been released;
- (3) The reportable quantity or other notification threshold that is the basis for notification;
- (4) The location of the release;

- (5) A brief description of the release including the medium or media into which the release occurred or is likely to occur, and the cause of the release;
- (6) The date, time, and duration of the release, and the date and time that the person in charge of the facility or vessel where the release occurred, obtained knowledge of the release;
- (7) The source of the release;
- (8) The name, address and telephone number of the caller;
- (9) The name, address and telephone number of the owner and operator of the facility or vessel where the release has occurred;
- (10) The name and telephone number of a contact person at the facility or vessel where the release has occurred;
- (11) Measures taken or proposed to be taken in response to the release as of the time of the notification, and any appropriate information relating to the ability of the owner or operator of the facility or vessel where the release has occurred to pay for or perform any proposed or required response actions;
- (12) The names of other federal, state, or local government agencies that have been notified of the release;
- (13) Any known or anticipated acute or chronic health risks associated with the release and where appropriate, advice regarding medical attention necessary for exposed individuals; and
- (14) Any other information which is relevant to assessing the hazard posed by the release, including but without limitation potential impacts to public health or welfare, or the environment.

Written Follow-Up Notification Contents

Notice, including all information provided in the verbal notification described above and any other pertinent information not previously provided, shall also be made in writing to the department. This written notice shall be post-marked no later than thirty (30) days after initial discovery of a release, and sent by certified mail or another means which provides proof of delivery.

Federal Requirements under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Releases of Reportable Quantities (RQ) of CERCLA hazardous substances must also be reported to the National Response Center at 1(800)424-8802.

This guideline is general in nature and is provided to assist in complying with HEPCRA and the SCP in Hawaii and does not have the force and effect of law. To ensure full compliance under the law, persons affected should review the appropriate Federal and State statutes and regulations. Failure to report a covered release under these laws and regulations may prompt EPA or State enforcement action including penalties not to exceed fines of \$25,000 per day per violation or imprisonment. Copies of the laws and regulations may be obtained by contacting the HSERC/HEER at 586-4249 or the EPCRA Hotline at 1(800)535-0202.

Hawaii State Department of Health Hazard Evaluation and Emergency Response Office (HEER) Hazardous Substance Inventory Guideline

WHO MUST SUBMIT AN INVENTORY FORM

You need to report hazardous substances that were present at your facility at any time during the previous calendar year at levels that equal or exceed reporting thresholds established for Hawaii Chemical Inventory Form/Tier II (HCIF) reporting under the Hawaii Emergency Planning and Community Right-to-Know Act (HEPCRA). These thresholds are as follows:

For Extremely Hazardous Substances (EHS) designated under section 302 of The Emergency Planning and Community Right-to-Know Act (EPCRA), the reporting threshold is 500 pounds (or 227 kg) or the Threshold Planning Quantity (TPQ) whichever is lower.

For all other hazardous chemicals for which facilities are required to have or prepare a Material Safety Data Sheet (MSDS), the reporting threshold is 10,000 pounds or (4,540 kg).

WHAT CHEMICALS ARE EXCLUDED

- 1) Any food additive, color additive, drug or cosmetic regulated by the Food and Drug Administration:
- 2) Any substance present as a solid in any manufactured item to the extent exposure to the substance does not occur under normal conditions of use:
- 3) Any substance to the extent it is used for personal, family, or household purposes, or is present in the same form and concentration as a product packaged for distribution and use by the general public:
- 4) Any substance to the extent it is used in research laboratory or a hospital or other medical facility under the direct supervision of a technically qualified individual:
- 5) Any substance to the extent it is used in routine agricultural operations or is a fertilizer held for sale by a retailer to the ultimate customer.

WHEN TO SUBMIT THE HCIF

The HCIF must be submitted by March 1 for the previous reporting year. HCIFs for the reporting year January 1, 1995 through December 31, 1995 must be submitted by March 1, 1996.

WHERE TO SUBMIT THE HCIF

Send completed Hawaii Chemical Inventory/Tier II Forms to each of the following organizations:

- 1) The Hawaii State Emergency Response Commission (HSERC)/HEER Office (586-4249)
- 2) Your Local Emergency Planning Committee (LEPC)
- 3) The fire department with jurisdiction over your facility

FILING FEE

Under Hawaii Revised Statutes Section 128D-2, a \$100.00 filing fee must be submitted for each facility covered under HEPCRA. Please make checks or money orders payable to the State of Hawaii General Fund. **No Purchase Orders will be accepted.** Enclose payment with the HCIF(s) that you mail to the HSERC/HEER.

PENALTIES

Any owner or operator who violates any HCIF reporting requirements shall be liable to the State of Hawaii for a civil penalty of up to \$25,000 for each such violation. Each day of a violation constitutes a separate violation.

Hawaii Emergency Planning and Community Right-To-Know Act (HEPCRA) Hawaii Chemical Inventory Form/Tier II (HCIF) - INSTRUCTIONS

FACILITY INFORMATION

Enter the full name of your facility.

Enter the full street address or state road. If a street address is not available, enter other appropriate identifiers that describe the physical location of your facility. Include city, state, zip code and island.

Enter the primary Standard Industrial Classification (SIC) code and the Dun and Bradstreet number for your facility. The financial officer of your facility should be able to provide the Dun & Bradstreet number. If your firm does not have this information contact the call 1-800-395-0792 to obtain your facility number or have one assigned.

FACILITY REPRESENTATIVE

Under Section 303 a facility representative shall be reported to the HSERC. Enter the facility representative's full name, mailing address and phone number.

OWNER/OPERATOR

Enter the owners's or operator's full name, mailing address and phone number.

EMERGENCY CONTACT

Enter the name, title and work phone number of at least one local person or office who can act as a referral if emergency personnel need assistance in responding to a chemical accident at a facility

Provide an emergency phone number where emergency information will be available 24 hours a day, every day. This requirement is mandatory. The facility must make some arrangement to ensure that a 24 hour contact is available.

CHEMICAL INFORMATION

The main section of the Hawaii Chemical Inventory Form requires specific information on amounts and locations of hazardous chemicals, as defined in the OSHA Hazard Communication Standard.

CHEMICAL DESCRIPTION

Enter the chemical name or common name of each hazardous chemical

Enter the Chemical Abstract Service registry number (CAS). For mixtures, enter the CAS number of the mixture as a whole it has been assigned a number distinct from its constituents. For a mixture

that has no CAS number, leave this item blank or report the CAS number of as many constituent chemicals as possible.

Check whether the chemical is or contains an Extremely Hazardous Substance (EHS). If the chemical is a mixture containing an EHS, enter the chemical name of each EHS in the mixture.

Check box for all applicable descriptors: pure or mixture and solid, liquid or gas.

PHYSICAL AND HEALTH HAZARDS

For each chemical you have listed, check all the physical and health hazard boxes that apply. These hazard categories are defined in 40 CFR 370.2. The two health hazard categories and three physical categories are a consolidation of the 23 hazard categories defined in the OSHA Hazard Communication Standard 29 CFR 1910.120.

MAXIMUM AMOUNTS

For each hazardous chemical, estimate the greatest amount in pounds present at your facility on any single day during the reporting period.

Find the appropriate range value code under Reporting Ranges.

Enter this range value code as the maximum amount.

AVERAGE DAILY AMOUNT

For each hazardous chemical, estimate the average weight in pounds that was present at your facility during the year.

To do this, total all daily weights and divide by the number of days the chemical was present on the site.

Find the appropriate range value under Reporting Ranges.

Enter this range value as the Average Daily Amount.

NUMBER OF DAYS ON-SITE

Enter the number of days that the hazardous chemical was found on-site.

STORAGE CODES AND LOCATIONS

List all non-confidential chemical locations in this column along with storage types/conditions associated with each location. You may list several locations for a particular chemical. Each column of boxes indicates a type of storage container (for example: an underground storage tank at ambient

pressure and temperature (B14) or a compressed gas cylinder at ambient temperature (L24)) and the corresponding line represents a location for that container.

STORAGE CODES

Indicate the code for the container types and the pressure and temperature conditions for that storage container.

STORAGE LOCATIONS

Provide a brief description of the precise location of the chemical so that emergency responders can locate the area easily. These descriptions must correspond to the site plan which you provide.

CERTIFICATION

The owner, operator or the officially designated representative of the owner or operator must certify that all information included in the HCIF submission is true, accurate and complete. On the first page of the report enter your full name and official title. Sign your name and enter the current date. Also, enter the total number of pages included in the Confidential and Non-confidential information sheets as well as all attachments. An original signature is required on at least the first page of the submission. Submissions to the HSERC, LEPC and Fire department must each contain an original signature on at least the first page. Subsequent pages must contain either an original signature, a photocopy of the original signature or a signature stamp. Each page must contain the date on which the original signature was affixed to the first page of the submission and the total number of pages in the submission.

Reporting Ranges

| <u>Range Value</u> | <u>From (Pounds)</u> | <u>To (Pounds)</u> |
|--------------------|----------------------|------------------------|
| 01 | 0 | 99 |
| 02 | 100 | 999 |
| 03 | 1,000 | 9,999 |
| 04 | 10,000 | 99,999 |
| 05 | 100,000 | 999,999 |
| 06 | 1,000,000 | 9,999,999 |
| 07 | 10,000,000 | 49,999,999 |
| 08 | 50,000,000 | 99,999,999 |
| 09 | 100,000,000 | 499,999,999 |
| 10 | 500,000,000 | 999,999,999 |
| 11 | 1 billion | greater than 1 billion |

Storage Codes for Container Type Temperature Conditions

Storage Codes for Pressure and

| | | | |
|---|------------------------------|---|---|
| A | Above ground tank | 1 | Ambient Pressure |
| B | Below ground tank | 2 | Greater than ambient pressure |
| C | Tank Inside building | 3 | Less than ambient pressure |
| D | Steel drum | | |
| E | Plastic or non-metallic drum | 4 | Ambient temperature |
| F | Can | 5 | Greater than ambient temperature |
| G | Carboy | 6 | Less than ambient temperature but not cryogenic |
| H | Silo | 7 | Cryogenic conditions |
| I | Fiber drum | | |
| J | Bag | | |
| K | Box | | |
| L | Cylinder | | |
| M | Glass bottles or jugs | | |

- N Plastic bottles or jugs
- O Tote bin
- P Tank Wagon
- Q Rail car
- R Other

Section 2

Appendix 2D

Hazardous Substance Release Notification Guidelines and Hazardous Substance Incident Notification Form

HEER Office Initial Release Notification Form

Date Reported:

Case Number:

Time Reported:

Confirmation Number:

Site Name:

Location:

Address:

City: ZIP:

Island:

Incident Description:

Substance Released:

Quantity Released:

Media:

Reported By:

Reporter's Phone

Initial Response
Actions:

ER:

ISST:

NFA:

Official Notification
Requiring Written
Followup?:

Initial Staff:

03-Feb-97

Section 2

Appendix 2E

Written Follow Up Form

Hawaii Hazardous Substance Written Follow-Up Notification Guideline

PLEASE PROVIDE THE FOLLOWING INFORMATION

Chemical Information

(1) Name (trade and chemical) of the hazardous substance which has been released: _____

Chemical Abstract Service (CAS) Registry Number: _____

(2) Approximate quantity of the hazardous substance released: _____

(3) The reportable quantity or other notification threshold that is the basis for notification: _____

| Regulated Substance | RQ |
|-----------------------|----|
| EHS | |
| CERCLA | |
| Title 11, Chapter 451 | |

Incident Information

(4) Location of the release: _____

(5) A brief description of the release: _____

Media into which the release occurred or is likely to occur:

Air Soil Ground Water Concrete Asphalt Stream Ocean Other

Cause of the release: _____

(6) Date of the release: _____

Time of the release: _____

Duration of the release: _____

Date: _____

Time: _____
that the person in charge of the facility or vessel where the release occurred, obtained knowledge of the release.

(7) Source of the release: _____

Contact Information

(8) Caller's
Name: _____
Address: _____
City: _____ State: _____ Zip: _____
Telephone number: _____

(9) Owner's
Name: _____
Title: _____
Company: _____
Address: _____
City: _____ State: _____ Zip: _____
Telephone number: _____

Operator's
Name: _____
Title: _____
Company: _____
Address: _____
City: _____ State: _____ Zip: _____
Telephone number: _____

(10) Name of a contact person at the facility or vessel where the release has occurred: _____

Telephone number: _____

Response Information

(11) Response measures taken thus far: _____

Any appropriate information relating to the ability of the owner or operator of the facility or vessel where the release has occurred to pay for or perform any proposed or required response actions: _____

(12) The names of other federal, state, or local government agencies that have been notified of the release: _____

Health Information

(13) Known or anticipated acute health risks: _____

Known or anticipated chronic health risks: _____

Advice regarding medical attention necessary for exposed individuals: _____

(14) Potential impacts to public health or welfare: _____

Potential impacts to the environment: _____

Section 3

SITE ASSESSMENT AND PRIORITIZATION



Section 3

SITE ASSESSMENT AND PRIORITIZATION

Following the discovery or notification of a release or threat of release, a number of activities will be conducted by the HEER Office to evaluate the degree of hazard posed to public health or welfare, the environment, or natural resources. This is an internal DOH decision making process and is subject to change by the HEER Office based upon new information. The owner or operator of a site may not be directly involved in this decision making process. This section is provided in order to provide some general information on the HEER Office process.

First, a State On-Scene Coordinator (SOSC) will determine if an emergency situation exists, such as the potential for fire, explosion, or catastrophic release, which may warrant an emergency removal action. Following emergency screening, the site will be further screened by a The HEER Office project manager to establish the relative priority the HEER Office will place on addressing the release or threat of release at the site. An additional goal of this process is to eliminate from further action those sites that do not pose a substantial danger to the public health or welfare, the environment, or natural resources.

3.1 Emergency Response Assessment

Following discovery or notification, all sites will be evaluated by a SOSC to determine if an emergency situation exists which may warrant an emergency removal action. If an emergency is identified, the response would begin immediately. In some instances, the potentially responsible party may already be conducting an emergency response at the time of notification. Emergency responses require immediate response and allow little or no time for general site assessment activities such as file searches or telephone investigations prior to site activity.

If an emergency response action is conducted at a site which addresses the entire release or threat of release, the site may be designated for No Further Action (NFA). (See Section 1.5.)

If an emergency response action does not address the entire release or threat of release, or if no emergency response action is taken, then the site will proceed to the next stage of HEER Office Site assessment and prioritization process.

3.2 Site Assessment and Prioritization

Sites that are not considered emergencies, and those sites that have been stabilized following emergency response actions, will be prioritized by the HEER Office for future response action through a site assessment and prioritization process. The site assessment will divide the sites into the following priority categories:

1. High priority sites
2. Medium priority sites
3. Low priority sites
4. No further action (NFA) sites

The site assessment and prioritization provides the HEER Office with a procedure for distinguishing between sites requiring further investigation and response from those sites which do not pose a threat to public health and the environment. While sites will generally be ranked based on the risks posed to public health and the environment, other factors may influence the final assignment of priority by the HEER Office, such as the degree of public interest, cumulative impacts from nearby sites, willingness of PRPs to conduct work, and other relevant factors.

3.2.1 Information Gathering for Site Assessment

In general, site assessments will be conducted by the HEER Office or PRPs by utilizing only existing site-specific data. In some instances, however, it will be necessary to collect some additional site-specific data in order to conduct an accurate site assessment. Additional data may be collected by either the HEER Office or a PRP under the direction of the HEER Office.

Information needed for site assessment and prioritization may be gathered from a variety of sources, including the following:

1. Review of existing information about a release, such as information identifying actual and potential receptors, source, nature and magnitude of a release or threat of release, and actual and potential pathways of exposure.
2. An off-site (i.e., perimeter) or on-site inspection, or both, taking into consideration whether such inspections can be performed safely.

3. Collection or development of additional information to further evaluate the source and nature of a release or threat of release, the actual or potential receptors and pathways of exposure.

In addition to utilizing existing and newly collected data, screening models may be utilized to provide additional insight into potential pathways and receptors.

3.2.2 Site Assessment Prioritization Procedure

The HEER Office will begin the site assessment by reviewing all of the criteria in the high priority category that may apply to the site. If a site meets any of the criteria in that category, it is ranked as a high priority site. If a site does not meet any high priority criteria, the medium priority criteria will be reviewed to determine if any apply to the site. The site will be ranked medium if any medium criteria apply. If the site does not meet any high or medium criteria, but does meet one or more low priority criteria, it will be ranked low priority. A site cannot be ranked in more than one category. A determination of No Further Action will be discussed in the following section.

3.3 Criteria for No Further Action

A site shall no longer be subject to response actions under the Environmental Response Law when the HEER Office determines that no further response is appropriate. The HEER Office reserves the right to re-open a site decision should additional information become available. In making such a determination, the HEER Office shall consider:

1. Any appropriate information to determine whether the site meets the minimum hazard threshold criteria contained in Section 5, and whether taking response action would be appropriate.
2. If response actions taken have been sufficient to address the release or threat of release.

3.4 Determination of Appropriate Response Action

Response actions other than emergency response actions fall into one of two categories: removal or remedial actions.

Removal actions are generally appropriate at sites where relatively simple and streamlined investigations will be needed to define the nature and extent of the contamination present and develop an appropriate cleanup plan. Remedial actions are generally appropriate at sites where more complex investigations will be needed and where a number of cleanup alternatives will be evaluated prior to selection of a final

cleanup plan. In addition, because the remedial process allows for a greater degree of public involvement in the investigation, remedy selection, and cleanup process, it may be appropriate to follow the remedial process at sites with a high degree of public interest.

The HEER Office will determine whether the response action required at a site should be a removal or remedial action. In general, the HEER Office will consider a number of factors in making this determination, including but not limited to:

1. The immediacy of the threat;
2. Planning time (including site characterization);
3. Implementation time;
4. The degree of risk to public health or welfare, the environment, or natural resources, including but not limited to:
 - (A) Actual or potential exposure to nearby human populations, animals or the food chain from hazardous substances or pollutants or contaminants;
 - (B) Actual or potential contamination of drinking water supplies or sensitive ecosystems;
 - (C) Hazardous substances, pollutants, or contaminants in drums, barrels, tanks, or other bulk storage containers, that pose or may pose a threat of release;
 - (D) High levels of hazardous substances, pollutants, or contaminants in soils largely at or near the surface, that may migrate;
 - (E) Weather conditions that may cause a release of hazardous substances, pollutants, or contaminants to migrate or be released; and
 - (F) Threat of fire or explosion;
5. Cost, including the extent to which deferral from removal to remedial will result in increased cost or increased risk to public health or welfare, the environment, or natural resources;
6. Community interest;
7. Site complexity;

8. The availability of other appropriate federal, state, county, or private response mechanisms to respond to the release; and
9. Other situations or factors that may pose imminent and substantial threats to public health or welfare, the environment, or natural resources.

Section 4

FIELD INVESTIGATION

Section 4

Field Investigation

4.1 Introduction

This chapter is to be used only as a general guide. Procedures described in this section are recommended for a remedial or large scale removal project in mind. Simple, small scale removal actions should address only those portions of this guidance which are necessary. All proposed sampling activities must be justified by site-specific considerations. The Hazard Evaluation and Emergency Response (HEER) Office recognizes that the level of study for a site is dependent on the site size, type of operations and complexity of environmental conditions. A given site may require more or less site specific information and sampling to adequately address areas of known or potential environmental concern. A Work Plan (WP), Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) must be developed to present all pertinent information to the HEER Office to complete and evaluation. Suggested formats for these documents are an Appendix to this Section.

4.2 Purpose of Field Investigation

The purpose of the field investigation is to:

- Identify areas of environmental concern and identify contaminants of concern;
- Delineate the horizontal and vertical extent of contaminants in all media at the site;
- Determine the general surface and subsurface characteristics of the site, which may include the depth to ground water;
- Identify the migration paths and actual or potential receptors of contaminants on or through air, soil, bedrock, sediment, ground water, and surface water, at a contaminated site;
- Collect all data necessary to evaluate response action alternatives;
- Collect all data necessary to evaluate the ecological impacts of the contaminants;

- Collect all data necessary to develop discharge limitations for any discharge to the environment which may be required for any removal/remedial action under consideration;
- Characterize all natural resource damages, including the nature and extent of injury or damage to flora and fauna, caused by the potential contaminants at the site;
- Identify containment and/or stabilization activities to prevent contaminant exposure to onsite receptors and to prevent the offsite migration of contaminants while response action alternatives are being evaluated.

4.3 Establishing Data Quality Objectives

Data Quality Objectives (DQO's) are qualitative and quantitative statements which specify the quality of the data required to support response decisions. These may be determined in either the Work Plan or the QAPP. DQOs are determined based upon the end uses of the data (site screening, risk assessment, removal or remedial decision) to be collected to characterize the site, evaluate response alternatives, determine design criteria, or monitor site conditions and/or response action effectiveness.

DQOs are established prior to data collection and are not considered a separate deliverable. Rather, the DQO development process is integrated with the project planning process, and the results are incorporated into various planning documents for the site investigation.

DQOs should be specified for each projected end point of data collection activity. All activities should be conducted and documented in a manner that ensures that sufficient data of known quality are collected to support sound response action decisions, on and off site.

The DQO process consists of seven steps. Even though the DQO process is stated as a linear sequence of steps, in practice it is iterative. During the first six steps, the planning team will develop the decision performance criteria that will be used to develop the data collection design. The final step of the process involves developing the data collection design plan (Sample and Analysis Plan) based on the DQOs. Every step should be completed before data collection begins. Each of the seven steps is described briefly below.

Step 1: State the Problem - Concisely describe the problem to be studied. Review prior studies and existing information to gain a sufficient understanding to define the problem.

Step 2: Identify the Decision - Identify what questions the study will attempt to resolve, and what actions may result.

Step 3: Identify the Inputs to the Decision - Identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement.

Step 4: Define the Study Boundaries - Specify the time periods and spatial area to which decisions will apply. Determine when and where data should be collected.

Step 5: Develop a Decision Rule - Define the statistical parameter of interest, specify the action level, and integrate the previous DQO outputs into a single statement that describes the logical basis for choosing among alternative actions.

Step 6: Specify Tolerable Limits of Decision Errors - Define the decision maker's tolerable decision error rates based on a consideration of the consequences of making an incorrect decision.

Step 7: Optimize the Data - Evaluate information from previous steps and generate alternative data collection designs. Choose the most resource effective design that meets all DQOs.

The DQO process is a flexible planning tool that should be applied more or less intensively as the situation requires. For projects that have multiple decisions, where the resolution of one decision only leads to the evaluation of subsequent decisions, the DQO process can be used repeatedly throughout the project. For small scale projects, the process may be completed in only one cycle.

4.4 Quality Assurance/Quality Control

Quality Assurance (QA) is the overall program for assuring reliability of monitoring and measurement data. Quality Control is the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process. All equipment and procedures involved in the collection, handling and analysis of the sample must be fully and clearly described. This information must demonstrate that adequate considerations for quality assurance will be taken.

Data collected at sites should be either screening data with definitive confirmation or definitive data as defined in Data Quality Objectives Process for Superfund, Interim Final Guidance, September 1993, EPA540-R-93-071. These two kinds of data are associated with specific quality assurance and quality control elements, and may be generated using a wide range of analytical methods (e.g., GC/MS, immunochemical

analysis, etc.). The definitions of screening data and definitive data are provided below.

4.4.1 Definition of Screening Data

Screening data are generated by rapid, less precise methods of analysis (e.g., active or passive soil gas surveys, immunochemical analysis) with less rigorous sample preparation. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion. Screening data provides analyte identification and quantification, although the quantification may be relatively imprecise. As a general guidelines, at least 10% of the screening data are confirmed using analytical methods (e.g. GC/MS) and Quality Assurance/Quality Control (QA/QC) procedures and criteria associated with definitive data. For large or small data sets this requirement may be adjusted to either obtain a representative set of definitive data or reduce the amount of duplicative QA/QC sample numbers. Screening data without associated confirmation data are not considered to be data of known quality. Pre-screening data (data that is unconfirmed and is not analyte specific) may be used qualitatively only.

Screening data QA/QC elements are as follows:

- Sample documentation (location, date and time collected, batch, etc.);
- Chain of custody (when appropriate);
- Sampling design approach (systematic, simple or stratified random, judgmental, etc.);
- Initial and continuing calibration;
- Determination and documentation of detection limits;
- Analyte(s) identification;
- Analyte(s) quantification;
- Analytical error determination (The procedure identified here measure the precision of the analytical method, and are required when total measurement error is not determined under confirmation step.): An appropriate number of replicate aliquots, are taken from at least one thoroughly homogenized sample, the replicate aliquots are analyzed, and standard laboratory QC parameters (such as variance, mean, and coefficient of variation) are calculated and compared to method-specific performance requirements specified in the QAPP;

- Definitive confirmation: as a general guideline, at least 10% of the screening data must be confirmed with definitive data as described below. At a minimum, at least three screening samples reported above the action level (if any) and three screening samples reported below the action level (or as non-detects, ND) should be randomly selected from the appropriate group and confirmed.

4.4.2 Definition of Definitive Data

Definitive data are generated using rigorous analytical methods, such as approved EPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data (e.g., chromatograms, spectra, digital values) in the form of paper printout or computer-generated electronic files. Data may be generated at the site or at an off-site location, as long as the QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error must be determined.

Definitive data QA/QC elements are as follows:

- Sample documentation (location, date and time collected, batch, etc.);
- Chain of custody (when appropriate);
- Sampling design approach (systematic, simple or stratified random, judgmental, etc.);
- Initial and continuing calibration;
- Determination and documentation of detection limits;
- Analyte(s) identification;
- Analyte(s) quantification;
- QC blanks (trip, method, rinsate);
- Matrix spike recoveries;
- Performance Evaluation (PE) samples (when specified);
- Analytical error determination (measures precision of analytical method): An appropriate number of replicate aliquots, are taken from at least one thoroughly homogenized sample, the replicate aliquots are analyzed, and standard

laboratory QC parameters (such as variance, mean, and coefficient of variation) are calculated and compared to method-specific performance requirements;

- Total error measurement determination (measures overall precision of measurement system, from sample acquisition through analysis): An appropriate number of co-located samples are independently collected from the same location and analyzed following standard operating procedures. Based on these analytical results, standard laboratory QC parameters such as variance, mean, and coefficient of variation should be calculated and compared to established measurement error goals. This procedure is recommended for each matrix under investigation, and may be repeated for a given matrix at more than one location at the site.

4.4.3 Quality Control Samples

Replicates (including split samples)

Replicates (duplicates, triplicates, field-splits, and spiked samples) are a check for sampling and analytical precision and accuracy. The HEER Office recommends collecting duplicates at a frequency of 1 sample per day or 10% of all field samples, whichever is greater, for all parameters and matrices. Replicates should be from sampling points which are known or suspected to be contaminated. Identify in the Field Sampling Plan the sampling points for replicates, if known, or explain how the locations will be selected.

Sampling precision is dependent upon both the sampling technique and the naturally occurring small-scale heterogeneity in the media being sampled. Poor precision among replicate samples may indicate a high degree of natural small-scale heterogeneity. When this occurs, it may be necessary to increase the number of samples or take steps to ensure analysis of more representative samples in order to properly characterize a site.

For large projects, replicates should be spread out over the entire site and collected at regular intervals. For example, replicates should not be collected from just one soil boring.

Replicates are collected, numbered, packaged, and sealed in the same manner as other samples; replicate samples are assigned separate sample numbers and submitted blind to the laboratory.

State the objective and describe how replicates will be collected.

When sampling for non-volatiles, the split samples should be collected such that each container is filled about half-way and then the first container filled to final volume, followed by the second container. For volatiles, vial number 1 from the first set should be filled first, followed by vial number 1 from the second set. Then vial number 2 from the first set, followed by vial number 2 from the second set, etc.

When soil is sampled in sleeves and the sleeves are sent directly to the lab, replicate samples should be collected as co-located sleeves by selecting adjoining sleeves from the same split spoon.

If samples are being split to two different labs, include this in the Field Sampling Plan.

Blank Samples

Blank samples are suggested for water and air sampling.

Blank samples are a check for cross-contamination during sample collection and shipment, and in the laboratory. Use analytically-certified organic-free (HPLC-grade) water for organic parameters. Use metal-free (deionized-distilled) water for inorganic parameters.

Blanks are collected, numbered, packaged, and sealed in the same manner as other samples, and submitted blind to the laboratory.

The FSP should describe how and when blank samples will be collected.

Types of blanks and the minimum number to be collected are listed below in order of collection preference.

Equipment Blank

An equipment blank should be collected when sampling equipment is decontaminated and reused in the field or when a sample collection vessel (e.g. a bailer or beaker) will be used. Use the appropriate "blank" water identified above to fill or rinse the sampling equipment after the equipment has been decontaminated, and pour or collect this water in the sample containers. The minimum number of equipment blanks to be collected should be either 1) one per matrix per day, or 2) one per matrix per day per sampling team.

Field Blank

Collect this type of blank when equipment decontamination is not necessary and when a sample collection vessel will not be used (e.g. with dedicated pumps). The field

bottle blank should be poured at a sampling point. Use the appropriate "blank" water identified above to fill the sample bottles. One field blank per area of investigation per day should be collected.

VOA Trip Blank

A VOA trip blank is prepared in a clean environment and kept in the cooler used to ship VOA samples; it provides a check for cross contamination during transport. Ship a VOA trip blank when there is no other type of blank for volatiles. All of the VOA vials must be shipped in the same cooler as the VOA trip blank.

4.5 Project Scoping

4.5.1 Field Sampling Plan

A Field Sampling Plan specifies the final configuration of the environmental monitoring or measurement effort required to satisfy the DQOs. It designates the types and qualities of samples or monitoring information to be collected; where, when and under what conditions they should be collected; what variables are to be measured; and the QA/QC procedures to ensure that sampling design and measurement errors are controlled sufficiently to meet the tolerable decision error rates specified in the DQOs. The Field Sampling Plan may consist of two documents; the Sample and Analysis Plan (SAP) and the Quality Assurance Project Plan (QAPP).

4.5.2 Quality Assurance Project Plan

The QAPP is the formal project document that specifies the operational procedures and quality assurance/quality control (QA/QC) requirements for obtaining environmental data of sufficient quantity and quality to satisfy the project objectives. The QAPP is required for all data collection activities that generate data for use in decision making. The QAPP contains information on project management, measurement and data acquisition, assessment and oversight, and data validation and useability. The QAPP integrates the DQOs, the data collection design, and QA/QC procedures into a coherent plan to be used for collecting data that are of known quality and that is adequate for the intended use of the data.

4.5.3 Data Quality Assessment

After the environmental data have been collected and validated in accordance with the QAPP, the data must be evaluated to determine whether the DQOs have been satisfied. The Data Quality Assessment (DQA) involves the application of statistical tools to determine:

- Whether the data meet the assumptions under which the DQOs and the data collection design were developed; and
- Whether the total error in the data is small enough to allow the decision maker to use the data to support decisions within the tolerable decision error rates expressed by the decision maker in the DQOs.

The DQA is an essential element of data evaluation because it helps to bring closure to the issues raised at the beginning of the DQO process. By verifying the assumptions required to draw scientifically valid and meaningful conclusions from the data, and by implementing the decision rule, DQA helps the decision maker determine whether the DQOs have been satisfied.

4.5.4 Sampling Strategy

The HEER Office recommends the following Sampling Strategy be followed in most field investigation activities. Field screening methods (with confirmation) could be used to characterize the entire site. Screening methods would delineate the hot spots both laterally and vertically. In order to achieve known quality data for DOH to accept decision making, in general at least 10% of the data must be confirmed by definitive methods. (Screening and Definitive Data is defined in detail in Section 4.4.) Samples taken from the hot spots and background areas should make up the 10% confirmation samples to allow the results to be used for response action decision making and/or risk assessment purposes. Screening methods should guide definitive methods in a single sampling event to reduce costs and time. Background samples may also be confirmed by definitive methods. The strategy is outlined as follows:

1. For compounds where immunoassay methods have been approved by the HEER Office (PCPs, PCBs, TPH, and PAHs), these methods may be used for field screening. As additional immunoassay methods are approved, they will be added to the list.
2. For volatile organic compounds (VOCs), a properly operated and calibrated field GC/MS may be used as a field screening method.
3. For inorganic compounds (metals), a properly operated and calibrated field XRF may be used as a field screening method.
4. In all data gathering activities, at least 10% of the field data must be confirmed by laboratory analysis in order to use the data for site cleanup decisions. Note: For risk assessment purposes, 10% lab confirmation may not be sufficient and more sample analysis by definitive methods may be required on a site specific basis.

5. QA/QC samples (i.e., replicates, blanks, spikes) must be collected in all cases.
6. The Data Quality Assessment must include a discussion of the resulting information from this process. If the Data Quality Assessment determines that the data is of acceptable quality, then it may be used in risk assessment determinations.

Other sampling strategies may be followed, as determined on a site by site basis. Those strategies which are less rigorous than that described above, must be approved by the HEER Office in writing. In all cases, data collected must be either screening data with laboratory confirmation or definitive data using approved analytical methods.

For a list of the recommended definitive data collection methods, see Section 4.4.2. Other methods will be allowed, as approved on a site specific basis.

The HEER Office reserves the right to require the submittal of raw data if validation of the data set is required. The raw data sets must be maintained for 5 years and should be available, in electronic form and hard copy, within 30 days of request by the HEER Office.

4.5.5 Ecological Concerns

Biological and chemical information should be collected to aid in the evaluation of ecological impacts to the environment and help to identify potential effects with regard to the implementation of response actions. This information should include a general identification of the flora and fauna in and around the site with particular emphasis placed on identifying sensitive environments, especially endangered species and their habitats and those species consumed by humans and found in human food chains.

Depending on special circumstances, data may be needed for species that have key ecological functions in particular ecosystems, such as primary or secondary producers, decomposers, scavengers, predators, or species that occupy key positions in the food chains of humans or other species. Bioaccumulation data on food chain organisms, such as aquatic invertebrates and fish, may be particularly important to both environmental risk and human risk assessment. Data gathered through biological assessment techniques (i.e., bioassays, and or field monitoring) may be useful in situations where there are complex mixtures, incomplete toxicity information.

If ecological impacts are a concern at the site, the HEER Office recommends the development of an ecologically focused field investigation plan when developing the DQOs. An Ecological Risk Assessment (ERA) is defined as follows:

“... a qualitative and or quantitative appraisal of the actual or potential effects of a hazardous waste site on plants and animals other than people or domesticated species.”

Ecological assessment comprises of four interrelated activities:

Problem Formulation - qualitative evaluation of contaminant release, migration and fate; identification of contaminants of concern, receptors, exposure pathway and known ecological effects of the contaminants; and selection of endpoints for further study.

Exposure Assessment - quantification of contaminants release, migration, and fate; characterization of exposure pathways and receptors; and measurement of estimation of exposure point concentrations.

Ecological Effects Assessment - Literature review, field studies, and toxicity test, linking contaminants concentration to effect on ecological receptors.

Risk Characterization - measurement of estimation of both current and future adverse effects.

Each element of the process can affect the others. In practice, the components do not always follow each other in a stepwise manner, and may actually find that all components are developed simultaneously.

The HEER Office recommends a phased approach to ERAs. Both phases consist of the above mentioned activities.

Phase 1 involves primarily a literature study. Historical site information is gathered. Habitat and biota are identified; including endangered and threatened species and potential ecological receptors. Potential contaminants of concern, potentially complete exposure pathways, and identification of assessment and measurement endpoints are identified. Past sampling data, if available, is analyzed and data gaps are identified, if any exist. From this analysis it is determined if further investigation is warranted.

Phase 2 includes site specific field observations to fulfill data gaps in exposure or ecological effects identified in Phase 1. Specific laboratory and field studies are designed to address more complex measurements endpoints. It may involve increased complexity and long term investigations to refine exposure and ecological risk characterization. It may include monitoring strategies for assessing the progress and effectiveness of response actions, and risk management decisions.

4.5.6 Site Health & Safety Issues

It is the responsibility of employers to protect the health and safety of their workers. As such, the HEER Office highly recommends that an employer develop a written health and safety program which incorporates the following:

- An organizational structure;
- A comprehensive work plan;
- A site specific health and safety plan;
- A health and safety training program;
- A medical surveillance program;
- Standard operating procedures for safety and health; and
- Any necessary interface between general program and site specific activities

Specific requirements can be found in OSHA Regulations 29 CFR 1910.120.

The HEER Office does not comment on or approve site specific Health and Safety Plans, but does require that one be in place for all field activities.

4.6 Environmental Sampling

Recommended sample control procedures are an Appendix to this section. Please refer to these procedures for all media to be sampled.

Prior to sampling any media, decontamination procedures should be adhered to closely to prevent the introduction of contaminants by sampling equipment. See Section 4.11 for Decontamination Procedures.

4.6.1 Media to be Sampled

Soils

Soil sampling may be required in situations where the source of contamination is known or where the potential for contamination exists. Objectives of a soil sampling program include determining the presence or absence of contamination, level of contamination, and defining the aerial extent and depth of contamination. Soil sampling can also aid in the investigation of ground water by identifying potential sources of ground water

contamination. However, the presence or absence of soil contamination does not necessarily denote the presence or absence of ground water pollution.

There are two basic techniques for soil sampling. Samples can be collected with some form of core sample drilling of boreholes, or they may be collected from the surface or trenches in which the samples are cut from the soil mass with hand held corers. In either case, the goal is to obtain the most accurate representative samples possible by causing the least amount of disturbance of the soil and thus avoiding the loss of volatile constituents.

Factors likely to influence the magnitude of the sample collection error for soil sampling are sample size, collection methods, and frequency of sampling. The most important of these are the methods for collection and the frequency of sampling. The tools used for collecting soil samples are limited and are not likely to be sources of error. The errors most likely occur in the use made of the sampling equipment. Proper replication of soil sampling procedures should ensure that the data obtained meet the QA/QC objectives.

Soil samples collected from backhoe excavation, the ground surface, soil stockpiles, or a manual soil coring device are collected in thin-walled stainless steel or brass cylinder at least 3 inches long by 1 inch in diameter that has been prepared by the laboratory doing the analysis or by the sampling team. Cylinders can be made to fit inside the preferred split-barrel or split-spoon core sampler.

In situations where the above procedure is inappropriate (i.e., semisolid samples), glass vials with Teflon seals and screw caps should be used.

After retrieving the sample, record the soil type, depth, sample location, general subsurface stratigraphy, and groundwater depth if appropriate and any other pertinent features in the field notebook. Also note the presence of hydrocarbon vapors or visual staining of the soils in the field notebook. The soil sample may be screened in the field. See Section 4.4.3 for additional information on field screening samples.

Soil Gas

Soil gas/vapor sampling may also be required to determine if a plume of vapors is present in the soil spaces. The objective of this sampling is to determine if the plume is migrating toward human or ecological receptors.

Soil gas sampling should be coupled with field GC for optimal results as a screening method. Passive soil gas sampling does not provide for quick turn around, but is acceptable for screening.

Groundwater

A ground water investigation must be conducted whenever there is a potential for ground water contamination based upon an evaluation of site specific characteristics and available data, from any area of environmental concern identified at the site. In addition, ground water investigations may aid in determining additional contaminant sources onsite. Circumstances which require a ground water investigation include the following:

- Sites at which contamination is at or may reach the seasonal or tidal high water table, basal aquifer, dike impounded aquifer, or perched aquifers overlying basal aquifers;
- Sites where contamination is found in on-site or off-site wells and may be attributable to the site under investigation;
- Sites which have had historical discharges to ground water;
- Sites at which soils or fill material may not attenuate potential contaminants (dependent on type of soil, contaminant of concern and subsurface structure);
- Sites where the characteristics of the soil or fill material and the contaminants indicate that soil is acting as a potential source of groundwater contamination.

Surface Water

Surface water sampling may be needed in conjunction with groundwater investigations. This sampling may be necessary to help evaluate the relationship of ground water and surface waters. Sampling should be designed to account for seasonal or short-term flow and water quality fluctuations (dry vs. wet weather), system hydraulics (obtaining flow proportioned samples) and contaminant characteristics (density, solubility, etc.).

Surface water sampling of flowing waterbodies (e.g. streams) may be required in limited circumstances. This is because a single sampling episode will only represent transient water quality and proper evaluation of results is difficult without strict sampling controls. For example, contamination of surface water is sometimes the result of an incidental release of contaminants such as the overflowing or breach of a surface impoundment. In these cases, it is not likely that routine surface water sampling will show contamination that has or may occur. Therefore, to document whether such releases occur, sampling should be conducted during or following periods of heavy rainfall when possible.

Sediment/Sludge

Sediment sampling should be conducted at water bodies on-site which receive or may have received any point or non-point source discharges. The collection of sediment/sludge samples may be required from lakes, ponds, lagoons, streams, rivers, channels, sewers, leachate sumps or collection sumps.

Sediment samples should be used in conjunction with surface water sampling in cases where contaminants tend to accumulate onto clay or organic matter and resists transport via water flow.

Air

Air surveillance may be required in situations involving the release of toxic materials into the air. Volatilization of organic chemicals and emissions of airborne particles can be a concern at hazardous waste sites. For sites at which it appears that air emissions are a problem (e.g., surface impoundments containing volatile organics, landfills at which there is evidence of methane gas production and migration), an air emissions monitoring program should be undertaken. A field-screening program is recommended to determine if there is an air pollution problem, both for volatile organic emissions and fugitive dust. Because of the highly variable nature of air emissions from hazardous waste sites, consideration of meteorological conditions at the time of sampling is essential for the proper documentation of potential air pollution.

4.6.2 Sampling Frequency and Locations

The determination of the number of samples needed to characterize a site is dependent upon the objectives (statistical performance, quality assurance, characterization of background, characterization of exposure pathways) and the site specific conditions, specifically, how the site's physical environmental setting influences the concentration and movement of potential contaminants of concern. For example, if the objective of the event is to determine whether the site is contaminated, a limited number of samples, from properly chosen locations, will yield useful information. In these instances, appropriate field equipment should be utilized as a tool to determine if contamination is present. If, however, the site is known to be contaminated and delineation of the contamination is the objective, a greater number of samples may be needed.

These guidelines are written in general terms since it would be very difficult to cover every potential situation. Determining appropriate sampling locations is often a matter of professional judgement, based on site specific characteristics. This includes physical characteristics of the area (drainage patterns, subsurface characteristics and historical changes in site use) as well as characteristics of the potential contaminants

(density, solubility, etc.). All such factors are to be considered and discussed in the Field Sampling Plan when proposing sampling locations. Determining the appropriate sampling frequency is necessary to assure that sufficient number of samples are collected to adequately confirm the presence or absence of contamination and/or to delineate the extent and variability of contamination. All proposed sampling locations, depths and frequency must be fully justified by site-specific considerations discussed in the Field Sampling Plan. Each Field Sampling Plan must present a detailed site specific evaluation and proposal which will be evaluated by the HEER Office on a case-by-case basis.

Detailed lithologic logs of all soil and monitoring well borings should be developed using the Burmeister or Unified Classification Systems. Borings should be field screened with a PID, OVA or HNu and readings recorded in the field logs/notes. The calibration specifications for the field monitoring equipment should be provided.

In areas of known soil contamination, it is recommended that the contaminated material be analyzed as soon as possible for waste classification. This will minimize time delays in securing appropriate cleanup and disposal services for excavated materials, and may lower transport and disposal costs if the material is classified as non-hazardous.

Screening samples are to be collected at locations where the presence or absence of contamination is to be established. This may include biased and/or random sampling conducted to evaluate the environmental media of concern.

In cases of known contamination, it is necessary to establish the extent and variability of contamination. This involves the collection of a sufficient number of samples to define clearly the horizontal and vertical extent of contamination (on and off-site). The extent of required cleanup will be based on the physical limits described by these sampling activities. It is therefore important to collect a sufficient number of samples to delineate clearly and precisely the extent of contamination. A concise definition of the area of contamination will limit expenditures for any required cleanup.

Also in areas of known contamination, caution should be taken with regard to drilling through aquitards to avoid unnecessary vertical spreading of contamination.

The Field Sampling Plan should describe the areas where samples will be collected and the types of matrices (soil, water, etc.) that will be sampled. The Plan should also explain the rationale for each sampling point, the total number of sampling points, and any statistical approach used to select these points.

When no sampling is proposed in an area of potential environmental concern, it must be fully justified. Justification may include a detailed aerial photographic history supporting non-use of open areas or previous sampling (with established protocols) at the area of concern. In general, however, all areas of potential concern will require

some sampling and analysis to document environmental quality. If historical information cannot be provided, sampling should be conducted.

Composite soil or water samples will not be acceptable for samples intended for volatile or semi-volatile organic analysis. This is due to the potential of mixing incompatible materials, the difficulty of evaluating analytical results (dilution effect and erratic analytical results), and potential loss of volatile compounds. This includes BTEX, TPH, and organic lead as well as other VOCs and SVOCs.

Environmental modeling should not substitute for actual data collection. For information on the proper application of models to field problems see Section 5.9 of this manual.

4.6.3 Establishing Background Values

The HEER Office recommends that background values only be determined for contaminants of concern which exceed human health and/or environmental Tier 1 Risk Assessment Levels (See Section 5.8).

Once a Tier 1 Risk Assessment level has been triggered, the available sample data should be evaluated on an area wide spatial basis. The spatial analysis will have two purposes. First, to define any possible source areas that correlate with known activities or geologic characteristics. Second, to define a data set that could be used for determination of a trigger level, i.e., the 95% Upper Tolerance Limit (UTL) for background. The area of concern can then be compared with the UTL to indicate possible contamination and the need for further investigation. The discussion and description of the "total" risk ensures that risk due to site activities is separable from that due to natural geological formations.

The HEER Office believes that this procedure focuses the level of effort on only those contaminants that are present above levels of concern based on either human health or environmental evaluations. Thereby, defining the specific background question and using all the available data to evaluate the source of the elevated concentrations without incurring extensive additional sampling costs and associated delays.

4.6.4 Delineation of Contamination

The delineation of the horizontal and vertical limits of contamination for all media should be conducted as part of the field investigation. Delineation samples should be biased to identify any migration paths of the contaminant. Samples should be biased based on professional judgement, area history, discolored soil, stressed vegetation, drainage patterns, field instrument measurements, odor and other field indicators. If soil samples within the saturated zone are required to identify the vertical limit of

contamination, a sample of the saturated soil should be collected, if sample recovery is possible, and analyzed.

4.7 Monitoring Wells

4.7.1 Monitoring Well Installation

The purpose of installing monitoring wells is to obtain basic information on the subsurface geology, nature of ground waters, and to identify the presence of contamination. When proposing the number and location of these wells the following should be considered: 1) location of areas of environmental concern, 2) type and degree of soil contamination, 3) vadose zone and aquifer characteristics (includes known and predicted ground water flow directions), 4) local geology (structure and stratigraphy as determined by subsurface investigation), 5) site topography, suspected contaminants and potential receptors (potable water supply wells).

Ground water sampling should initially involve the uppermost water bearing zone including perched water zones. The well screen for monitoring wells must bridge the water table for the initial investigation. When ground water contamination is noted in initial investigations, more extensive sampling of the ground water may be required to define horizontal and vertical extent of contamination. Relatively deeper wells may also be required when the potential contaminant is denser than water, or site stratigraphy or geohydraulics indicate contaminants may have migrated vertically. All well construction details, including materials, and screen depth and length, are to be justified in the Plan. When contaminants are denser than water, and present at concentrations that may indicate the presence or absence of free product the Plan should specify that the method of sample collection is from the bottom of the well using a double check valve bailer with a flow valve.

Monitoring wells should be located so that any contaminant that has migrated from the site into the first water bearing zone will be detected. The number of monitoring wells will be site dependent. Initially, wells shall be placed hydraulically up and down gradient of the source or suspected source. Results of sampling from these wells may indicate the need for additional monitoring wells, including crossgradient wells.

If ground water contamination is detected in the first water bearing zone, deeper monitoring wells may be needed to be installed until the extent of contamination is delineated or a confining unit is encountered. If a continuous confining unit is encountered, a sample of this unit should be collected for permeability testing. If the unit is determined to be confining, double-case monitor wells, installed to depths below this unit, may be necessary. Pumping tests may also be required to determine if the water bearing zones are hydraulically connected.

Additional Information about monitoring well diameter, casing and screen material, screen length and depth of placement, sealing material, well development, and well security is provided in Chapter 1, "Monitor Well Design and Construction", Ground Water, Volume II: Methodology, July 1991, EPA/625/6-90/016b.

Two rounds of static water level measures must be obtained to plot and verify ground water flow direction(s). Static water level measurements must be corrected for tidal or barometric pressure influences. Acceptable flow directions should confirm that monitor well(s) are located downgradient and adjacent to the area(s) of environmental concern. Sampling episodes and static water level measures of monitoring wells should be separated by a minimum period of thirty days. The initial ground water samples should be taken no sooner than 14 days after well installation and development.

Modeling can be used to fill in data gaps but it should not substitute for actual data collection. For additional information about modeling see Section 5.9 of this manual.

The plan should include the proposed location of monitoring wells on a scaled (1"= \leq 50') site map. The map should identify the property boundaries and all areas of known or potential environmental concern. The proposed well construction specifications, including the depth of the well in relation to the first water bearing zone (if known) should be detailed in the Plan. Well sampling methods should be proposed such that they take into consideration the solubility of the chemical contaminants of concern.

During well installation split-spoon samples at pre-determined (i.e., five foot) intervals must be collected and detailed lithologic logs of soil and monitor well borings shall be obtained using the Burmeister or Unified Classification Systems. Borings logs for monitoring wells shall be prepared. A driller's log shall not substitute for a boring log prepared. Once the well has been installed, it must be surveyed and the longitude and latitude coordinates must be recorded.

Microwells

The HEER Office acknowledges the trend toward using Direct Push Technology (DPT) for obtaining groundwater and soils samples. We encourage the use of DPT for these purposes. However, until the DPT trend has demonstrated its relevance and acceptance by regulatory agencies, the DOH will not accept proposals for their use in lieu of monitoring wells.

4.7.2 Monitoring Well Sampling

A minimum of two independent sampling events per monitoring well is required to complete the initial ground water investigation. The purpose of a second round of

water quality analysis is to confirm the presence of contamination or to verify the results where no contamination is detected. Invalid results will result when acceptable field sampling and laboratory QA/QC measures are not employed and documented. Acceptable sample collection and analysis procedures are detailed in the following references:

- ASTM Standards on Ground Water and Vadose Zone Investigations, Second Edition, 1994; and
- Chapter 2, "Ground-water Sampling", in Ground Water, Volume II: Methodology, July 1991, EPA/625/6-90/016b.

During the initial two rounds of monitoring well sampling, static water level measurements must be obtained to plot, establish and verify ground water flow direction(s). The device/instrument used to determine monitoring well water levels should have a resolution to one-hundredth of a foot. Groundwater flow directions, determined from the initial two rounds of sampling, should confirm that the monitoring well(s) are properly located, upgradient, downgradient and adjacent to the area(s) of environmental concern. Water level measurements should be corrected for the presence of separate phase product should it exist. Separate isopleth maps should be prepared that show product thickness and concentrations of dissolved phase components. Sampling episodes and static water level measurements of monitoring wells should be separated by a minimum period of thirty days. The initial ground water samples should be collected no sooner than 14 days after well installation and development.

Monitoring wells should be purged prior to sampling (static water levels must be taken prior to purging). Purge volumes should be based on stabilization of indicator parameters such as dissolved oxygen (D.O.), specific conductance, turbidity, oxidation/reduction potential, pH, and/or temperature.

The DOH encourages the use of micro-purging techniques. For micro-purging, sampling devices dedicated within the screen zone must be inserted at least 24 hours prior to purging. Bailers and portable pumps should not be a part of the micro-purging system. After well purging, samples should be collected no later than 2 hours later. Preferably, the sampling should be conducted immediately following proper purging. Flow rates for micro-purging must be low, typically 50 to 250 ml/minute. Therefore, high flow pumps should not be used.

The goal in establishing a well purging strategy is to obtain a representative sample from the water bearing geologic materials while minimizing the disturbance to the regional flow system and the affects of monitoring well design and construction to the collected sample. To accomplish this goal, a basic understanding of well hydraulics and the effects of pumping on the quality of water samples is essential. Water that has

remained in the well casing more than about 2 hours has had the opportunity to exchange gases with the atmosphere and to interact with the well casing material. Therefore, the chemistry of water stored in the well casing is not representative of that in the aquifer and should not be collected for analysis. Purge volumes and pumping rates should be evaluated on a case-by-case basis.

When applicable, all purging must be completed in a manner so as to minimize the loss of volatile organics. Certain low-yield wells may dictate a unique purging strategy. If possible, the purging operation should not cause the well to go dry. Proposed purging equipment and procedures must be detailed in the plan.

In summary, well purging strategies should be established by (1) determining the hydraulic performance of the well; (2) calculating and selecting reasonable purging requirements, pumping rates, and based on hydraulic conductivity data, well construction data, proper indicator parameters, site hydrologic conditions, and anticipated water quality; (3) measuring the well purging indicator parameters to verify chemical "equilibrated" or stabilization conditions; and , (4) documenting the entire effort (actual pumping rate, volumes pumped, and purging parameter measurements before and after sample collection).

Dedicated bailers or bladders constructed of inert materials (Teflon or stainless steel) should be used to collect samples for organics. The sample should be taken from within the water column (i.e. the sampler should be fully submerged before it is withdrawn) within two hours of the purging operation. Note: Sampling for petroleum hydrocarbons should also include sampling at the top of the water column to check for floating product. All proposed sampling equipment and procedures are to be detailed in the Plan.

Field logs for all water sampling should be maintained and should include the information outlined below. This information is to be used to evaluate the ground water results and must be included in the sampling results report submitted to the HEER Office. The results should include:

- Date/time/weather
- Sampler/geologist name
- Well coordinates - longitude and latitude
- Static water level (distance from top of casing to water) prior to purging
- Total well depth (from top of casing)
- Casing diameter

- Actual volume purged (including time)
- Purging method/equipment (indicator parameters if any)
- Purging rate (if any)
- Sampler type
- Presence and thickness of any free product layer
- General conditions (odors, field measures, etc. prior to and after purging/sampling)

4.7.3 Production/Potable Well Sampling

Collection of water samples for analysis from wells other than monitoring wells must be approved by the HEER Office. Raw water samples collected from a supply well are to be taken as close to the well head as possible (before any treatment). The well should be purged long enough to obtain a representative sample of drawn water with a minimal residence time in the collection/distribution system.

4.7.4 Ongoing Monitoring Programs

The HEER Office recommends that once a monitoring well has been installed, that well should be sampled on a regular basis. During the first three years after installation, it should frequent enough to establish any seasonal variation (2 or 4 times per year). Subsequently, the well should be sampled on at a minimum of an annual basis. If a well is not needed for any substantive purpose, it should be abandoned in accordance with guidance on well abandonment, as contained in the following section. Prior notification should be sent to the HEER Office.

4.7.5 Abandonment of Monitoring Wells

Monitoring wells and soil borings must be properly decommissioned and closed once they no longer serve the purpose for which they were constructed. For sites undergoing response activities, No Further Action letters will not be issued until the HEER Office has been provided with sufficient documentation that demonstrates closure of monitoring wells or soil borings in accordance with the DOH's guidance.

To facilitate the policy, all site work plans submitted for DOH review that propose construction of monitoring wells or soil borings, shall include provisions for decommissioning and closing the monitoring well or soil boring. Guidance on this

portion of a work plan will be in accordance with and consistent with the applicable DOH programs having project oversight.

Any site where the PRP constructs monitoring wells or soil borings without DOH review shall also make provisions to decommission and close the wells or borings according to the guidance below.

This guidance shall be adhered to unless the PRP obtains DOH approval for allowing monitoring wells to remain in place. This guidance is based upon the assumption that monitoring wells are of relatively small diameter (<1 foot). If a larger diameter well is to be decommissioned, revised procedures may be used. The owner's request must state the purposes/advantages for allowing the monitoring well(s) to remain and detail what consequences if any may result from decommissioning/closing the well(s). As for soil borings, no open soil borings shall be allowed to remain in place. Soil borings constructed for response activities shall be backfilled with neat cement grout.

Guidance on decommissioning monitoring wells is as follows:

1. Retain the services of a geotechnical consultant to coordinate and supervise the backfilling operation and to submit the necessary information for formal file closure.
2. Notify the HEER Office at least one week prior to commencing the backfilling operation. You will be informed if departmental personnel will be present to witness the backfilling operation. If you conduct the backfilling operation without notifying the Department, you may be required to **re-excavate and re-backfill** the monitoring well under proper witnessing.
3. Complete and submit the DOH standard form titled "Abandonment of Monitoring Well Summary Report". The form must be completed to the satisfaction of the Department. Please review the form carefully and be aware that during the backfilling process, the consultant must record various information pertinent to the operation.
4. Remove any sediment/sludge in the well down to the original well depth.
5. Remove or permanently seal all casing including the screened interval of the monitoring well. Seal annular space if DOH approves of leaving the casing in place.
6. The monitoring well shall be backfilled with either a clean (non-deleterious) soil in a manner as specified in Option No. 1, or with a neat cement as specified in Option No. 2.

Option No. 1

- A. Measure and record the open hole depth and record the depth and diameter measurements of the well. Remove any loose material from the monitoring well. Cut monitoring well stickup casing to ground level.
- B. Backfill the well with a silty clay or clayey silt soil. The soil shall be free of deleterious material. If possible, on-site soils shall be used. The moisture content of the soil shall be maintained near the "optimum" percent to facilitate the compaction of the soil. Water should be available to moisten dry soil to achieve optimum moisture content, if necessary. Any rock aggregates within the soil matrix shall not exceed 1-2 inches in diameter and shall not constitute more than 50 percent by weight of the backfill material.
- C. Place and compact the soil (fill) in thin lifts. The lifts shall be compacted by mechanical means. This method of compaction shall be utilized until the well's depth below the ground surface is five (5) feet.

From depths of approximately five (5) feet to finish grade, the fill shall be mechanically compacted with appropriate compaction equipment to approximately match or exceed the surrounding soil density. Field soil density tests are not a requirement for the summary report; however, provisions shall be made to allow for additional compaction if satisfactory compaction cannot be achieved by the prescribed method as determined by the Department.

- D. The Department shall consider the backfilling field work complete when the final lift for the well and any ancillary excavations is compacted, and its finished grade matches the surrounding grade.

Option No. 2

- A. Remove all loose material from the well bore as described in numbers 4 and 5 above. Measure the well to determine the open hole depth and record the depth and approximate diameter of the well.
- B. Backfill the well with a neat cement (cement slurry). The neat cement shall have a water to cement ratio of approximately 6 gallons of water per 94 pound sack of cement and a minimum design strength of 2500 pounds per square inch (psi). The neat cement shall completely fill the well bore up to the top of the cased section of the well.
- C. If the neat cement is ordered as ready-mix, a purchase order receipt shall be submitted to the Department to substantiate that the specified mix ratio and the minimum design strength of the neat cement was used to backfill the well.

- D. If on-site mixing of neat cement is conducted to backfill the well, a construction materials testing laboratory shall be contracted to make a set of neat cement cylinders, and to test the cylinders for 7-day and 28-day compressive strength. Other methods to measure compressive strength may substitute for the cylinders. The substitute method shall be approved by the Department prior to the backfilling event. You are advised to give special attention to this strength requirement because an inadequate strength value may require you to re-excavate and re-backfill the monitoring well with proper strength material.
- E. The Department shall consider the backfilling complete when the neat cement has hardened and no settlement has occurred. If settlement occurs, additional neat cement shall be added to compensate for the amount settled.
- F. If unanticipated conditions arise during the backfilling operation that prevents the execution of the prescribed procedures, the backfilling operation should be suspended until the Department concurs with any procedural modifications needed to complete the backfilling operation.

The abandonment procedures for decommissioning monitoring wells do not address any other closure requirements of other county, state, or federal agencies, nor does it serve to absolve the owner of any responsibilities associated with the past use of the well or any event which may occur after the well has been decommissioned to the satisfaction of the Department.

4.8 Soil Borings

Equipment selected for sampling will depend on soil characteristics and intended sampling depths. The equipment and method chosen must provide for obtaining representative samples with minimal disruption (mixing) of the recovered sample.

All analytical samples are to be collected at six inch increments or less (e.g. as six inch section of boring) unless otherwise approved in writing by the HEER Office before sampling starts. Continuous sampling is normally not required for deep borings unless site stratigraphy information is to be obtained. Some sampling devices (e.g. split spoon samplers) come in lengths of two feet. In such cases, 6" incremental portions are to be collected as individual samples.

Accurate field logs are essential to the evaluation and interpretation of sample analytical results. A sampling log for each sampling point should be prepared which includes:

- Date/time/weather,
- Sampler/geologist/soil scientist name(s),
- Driller name,
- Boring coordinates - longitude and latitude,
- Sample point identification (same as in Plan summary table),
- Sketch showing the sampling point location (including reference distances),
- Diameter,
- Depth to water and/or bedrock (refusal) when encountered,
- Soil profile,
- Sample recovery (and portion submitted for analysis),
- Sampling equipment used,
- Field measures (where appropriate),
- General comments (e.g. odor, staining, etc.).
- Blow counts.

Bore holes at or near the water table should be sealed immediately after sampling, with non-shrinking impermeable material. These holes may otherwise act as a conduit for contamination. All procedures and materials for sealing bore holes should be outlined in the Plan for approval by DOH.

4.8.1 Direct Push Technology

In general, the HEER Office will accept the use of Direct Push Technologies (DPT) for soil, soil gas, and ground water data collection purposes on a site by site basis. Such use can be for evaluating groundwater and to optimize placement of ground water monitoring wells. However, due to the relative newness of DPT, the technology has not been clearly demonstrated to yield comparable analytical results for all analytes of concern under all subsurface conditions. The HEER Office is following the current trend toward using DPT. Since many companies are now in the process of developing

their own DPT, the HEER Office will proceed cautiously in its acceptance of these technologies for long term monitoring purposes, where no monitoring wells exist.

The use of DPT's must encompass procedures for equipment installation, sampling, and QA/QC. Site specific and data quality objectives must be discussed in any site work plan that proposes using DPT.

4.8.2 Sampling Depths

Soil borings are to be extended to a depth suitable for characterization of subsurface conditions and soil contamination. A select number of borings are to be extended below the intended sampling depth. Information from these borings (i.e. logs) is to be used to verify subsurface conditions (soil types, ground water depths, etc.). Boring logs must be submitted for all borings installed. Test borings used for geotechnical and/or hydrologic investigations, provided that these borings are plugged with impermeable material upon completion of the investigation, are excluded from the injection well permit requirements of HAR, Title 11, Chapter 23.

Soil samples collected to "screen" an area of potential concern are typically collected at the surface (0-6"), with other samples collected at lower increments. Due to the potential for volatilization, soil samples collected for volatile organics in an area of potential concern should be taken at 18-24" or deeper. Sampling depths will be dependent on factors such as the soil characteristics, contaminant mobility and the history of the area of concern. Intended sampling depths for volatile organics must be fully discussed in the Field Sampling Plan. In all cases, samples are to be collected as discrete 6 inch sections/intervals unless approved in writing by the HEER Office before sampling starts. Additional sampling of thinner intervals is to be completed in cases where the surface grade has been changed or deep borings indicate a layer of contaminated material.

Sampling depths in areas of known contamination may be guided by visual observations, field screening methods (e.g., photo-ionization detector, immunoassay, field GC/MS) and/or subsurface conditions (e.g. confining layers). It is important to collect a sufficient number of samples to clearly define the depth of contamination. In some cases it may be advisable to collect samples well beyond the suspected zone of contamination. These samples may be held and analyzed at a later time if the suspected "clean" area is shown to be contaminated through screening analysis. In all cases, however, sample holding times referenced in the analytical method must not be exceeded. This information will define the area at which the cleanup may be required, so cleanup costs may be lowered by concisely delineating the cleanup area.

4.9 Sample Collection

4.9.1 Analytes

Analytes should be chosen on a site specific basis, but should initially include a comprehensive suite of contaminants. After an overall understanding of the contaminants of concern has been developed, the analytes may be limited to only those necessary to provide useful information to answer the DQOs.

A comprehensive suite of contaminants may be generated by comparing the site history with the US EPA Target Compound List plus 30/Target Analyte List (TCL+30/TAL) or Priority Pollutant plus 40 (PP+40) scans, petroleum hydrocarbons, and pH. These shall be conducted when contaminants in an area are unknown or not well documented, although a limited contaminant list may be used subject to HEER review of documentation. These lists are included as an appendix to this Section of the manual.

Information sources for determining analytes and other potential areas affected may include:

- Previous field screening or investigations at the site (x-ray fluorescence, active and passive soil gas, geophysics, enzyme immunoassay tests, etc.),
- Historical aerial photographs and Sanborne Fire Insurance maps,
- Interviews with site personnel (past and present),
- Hazardous waste records and manifests,
- Physical characteristics of the site (odors, stained soil, stressed vegetation),
- Research about degradation products of the target compounds (e.g., trichloroethane may degrade to dichloroethene and vinyl chloride).

All ground water samples must be analyzed for Total Dissolved Solids (TDS), specific conductance and pH in addition to specific analysis. When knowledge of the fate and transport of ground water contaminants is needed, more comprehensive sampling, i.e. major cations, anions, Total Organic Carbon (TOC), conductivity, and Dissolved Oxygen (DO) may be required during ground water investigations.

4.9.2 Analytical Methods

Analytical methods used shall have been published or approved by organizations with recognized expertise in the development of standardized analytical methods. These organizations include, without limitation:

1. U.S. Environmental Protection Agency;
2. American Society for Testing and Materials (ASTM);
3. American Public Health Association (APHA);
4. National Institute for Occupational Safety and Health (NIOSH);
5. Association of Official Analytical Chemists (AOAC);
6. American Water Works Association (AWWA);
7. Hawaii Department of Health (HDOH);
8. U.S. Army Toxic and Hazardous Materials Agency (USATHMA);
9. U.S. Department of Defense; and
10. U.S. Department of Energy.

Table 4-1 is a list of recommended definitive analytical methods for common constituents. Other methods may be used if justified on a site specific basis and approved by the HEER Office.

Table 4-1**Definitive Analytical Methods**

| Analytical Constituent | Soil Method | Water Method |
|---|--|---|
| TPH as gasoline | 5030/8015, or LUFT Method | 5030/8015, or LUFT Method |
| TPH as diesel | 3550/8015, or 3540/8270 or 3550/8270, or LUFT Method | 3550/8015, or 3510/8270, or 3520/8270, or LUFT Method |
| TPH as oil & grease | 3550/5520 C or F | 5520 C or F |
| Benzene, Toluene, Ethylbenzene | 5030/8015, or 5030/8020, or 5030/8240 | 5030/8015, or 5030/8020, or 5030/8240, or 602, or 624 |
| Polynuclear Aromatic Hydrocarbons (PAH/PNA) | 3540/8310, or 3550/8310, or 3540/8270, or 3550/8270 | 3510/8310, or 3520/8310, |
| Halogenated Volatile Organics | 5030/8010 | 5030/8010, or 601, or 624 |
| Volatile Organics | 8240 | 8240/8260, or 624 |
| Semi-volatile Organics | 8270 | 8270, or 625 |
| Metals | 7000 Series | 200 series |
| Polychlorinated biphenyls | 3540/8080, or 3550/8080 | 3550/8080, or 608 |
| Pesticides | 3540/8080 | 608 |
| Chlorinated Hydrocarbons | 8120/8270 | 612 |
| Dioxins/Furans | 8280/8290 | 613/1613 |

4.9.3 Field Screening Methods

Field monitoring equipment (e.g. photo-ionization detector) may be used as a preliminary screening technique or to guide field operations, but is generally not acceptable to document the absence of contaminants. This type of equipment may, in fact, be required to assure worker safety. All such equipment should be calibrated in accordance with manufacture's instructions to assure reliable operations. The calibration procedure, including frequency is to be outlined in the Field Sampling Plan.

Field screening methods are limited as follows:

1. Field screening methods for all sampling matrices (soil, water, air) can only be used under the following conditions:
 - (A) For contaminant delineation if contaminant identity is known or if there is reasonable certainty that a specific contaminant may be present (for example, benzene, toluene, ethylbenzene, xylene in the case of sampling for a gasoline release); or
 - (B) To bias sample location to the location of greatest suspected contamination.

Field screening methods shall not be used to verify contaminant identity or uncontaminated zones.

4.9.4 Immunoassay Methods Used as Field Screening Methods

Immunoassay analysis may be used to delineate several groups of organic compounds including PCB, TPH, BTEX, PCP and PAH in soils and groundwater. Extraction from soil samples is required and direct analysis of liquid samples is possible. In the immunoassay method a colorimetric reaction occurs when antibodies that are not bound by a specific contaminant of concern are exposed to a developing solution. When immunoassay methods are used to obtain screening data, at least 10% of the data should be confirmed using analytical methods (e.g. GC/MS) and Quality Assurance/Quality Control (QA/QC) procedures and criteria associated with definitive data.

The HEER Office recommends the use of immunoassay methods for the collection of screening data of known contaminants (i.e., BTEX, PCP, PCB, TPH, TNT and/or PAH). For screening applications of known contaminants, specificity, sensitivity, and cost effectiveness of immunoassay methods are excellent. However, it is not particularly applicable to the identification and characterization of unknown contaminants at waste

sites when compared to much more comprehensive techniques such as gas chromatography/mass spectrometry (GC/MS).

Immunoassay methods may be used for field delineation of contamination in soils and field screening of water. This method may expedite site investigation and contaminant delineation while providing better site definition at a reduced cost. It may provide field personnel with real-time information which may be used in making field decisions regarding site delineation and to assist in focusing the investigation on the area of concern.

The following EPA methods are approved for use by the HEER Office:

- Method 4010: Pentachlorophenol (PCP) in Water and Soils by Immunoassay;
- Method 4020: Polychlorinated Biphenyls (PCBs) in Soil by Immunoassay;
- Method 4030: Total Petroleum Hydrocarbons (TPH) in Soil by Immunoassay, and
- Method 4035: Soil Screening for Polynuclear Aromatic Hydrocarbons (PAHs) by Immunoassay.

The two methods in the final stages of validation, i.e., field testing are:

- Method 4015: 2,4-D in Water and Soils by Immunoassay and
- Method 4031: Soil Screening for BTEX by Immunoassay.

Limitations of Immunoassay Analyses

Interferences and limitations for immunoassay methods may include the following:

- The user must pay close attention to the specificity of the immunoassay analysis. For example, the immunoassay may be used for a class of compounds, like PCBs, and may not provide specific quantification for specific compounds of concern, like a particular arochlor. Each kit should contain a list of possible interfering compounds.
- Up to twenty percent (20%) false positives and up to ten percent (10%) false negatives can be expected dependent on the kit used, compound analyzed and matrix.

- Temperature fluctuations may cause differences in chemical reactions which will give different results. Therefore, standards should be run along side of each group of samples analyzed.

When immunoassay methods are used as screening data, the HEER Office recommends that the screening data QA/QC elements described above in Section 4.9, Definition of Screening Data, be followed. At least 10% of the screening data should be confirmed using analytical methods (e.g. GC/MS) and Quality Assurance/Quality Control (QA/QC) procedures and criteria associated with definitive data. Data that is not confirmed will only be considered qualitative in nature. The Data Quality Assessment should discuss the limitations and the implementation issues associated with use of the immunoassay methods.

Field sampling personnel should receive training from the immunoassay kit manufacturer before data collection activities begin.

4.9.5 XRF Field Screening Methods

The HEER Office recommends the use of field portable X-Ray Fluorescence (XRF) instrument to detect heavy metals in soil below 50 ppm. This method provides field personnel with real time information, which may be used in making field decisions. Good correlation (0-30% difference) has been shown between the data generated by XRF and current definitive methods. Limitations of the method include:

1. Hot weather (greater than 75 degrees F) may affect the electronics and the battery.
2. Several metals fluoresce at similar wavelengths. All fluorescence data should be retained so that secondary line (wavelength) analysis may be conducted, if required.
3. The instrument should not be exposed to rain.
4. The element composition of the analysis chamber should be considered when developing a site specific work plan. This may be true for analysis of lead or mercury.
5. The validity of results is a function of the capacity of the technician.
6. Detection levels may be above site specific standards for certain metals.

4.9.6 Methanol Preservation for Soil VOC Samples

The HEER Office is very interested in soil samples submitted for volatiles analyses (VOCs) be preserved in methanol immediately after collection, unless samples are stored in either a brass tube or an acceptable sampling device (i.e., an EN CORE sampler or its equivalent).

If methanol preservation is used, then samples may be stored in either a brass tube or an acceptable sampling device, but holding times should be followed:

- Samples stored in the brass tube should be preserved in methanol within two hours after collection.
- Samples stored in a cartridge (i.e., a part of the sampling device) should be preserved in methanol within 48 hours after collection.
- Diesel range organic samples (i.e., C6 to C10) may be stored in a cartridge, but preservation holding times still should be met.
- If a consultant arranges for the laboratory to preserve samples for volatile analyses in methanol, the samples should arrive at the laboratory within 40 hours of collection.

Holding Times

HEER Office is extending the analysis holding time to 21 days for samples preserved in methanol. An additional seven days allows for confirmation analyses (using the original sample extract) past the original 14-day holding time. Confirmation samples should be analyzed within a maximum of 21 days from the collection date. The holding time for shipping samples stored in a coring sampler is 40 hours.

4.10 Laboratory Selection

The Field Sampling Plan should identify the analytical laboratory that will perform the analysis of all samples. Laboratories performing analysis should conform to at least one of the following certification requirements:

- The laboratory must be a Hawaii Certified Water Laboratory for all parameters for which analysis will be performed, or the appropriate category of parameters.
- The laboratory must be a certified water laboratory in a state or federal certification program that has applied for and achieved reciprocity with the State of Hawaii certification program. (See Note Below)

- The laboratory must currently be a member of the USEPA Contract Laboratory Program (CLP) as described in the current version of the "Invitation for Bid" (IFB) Contract. The laboratory must maintain certification or membership in the EPA-CLP-IFB Program for the duration of the sampling study.

Loss of certification for any parameter during the term of the study may result in rejection of analytical results for that parameter. The HEER Office should be informed of any change in laboratory certification status.

The HEER Office reserves the right to audit the laboratory, prior to sampling, or at any time during the project. Such an audit may include instrument/analytical data stored on magnetic disks (e.g. GC/MS). Performance evaluation samples may be submitted by the HEER Office and be used as a basis for laboratory approval.

NOTE: The HEER Office acknowledges that there is currently no State of Hawaii laboratory certification requirements for hazardous waste data analysis. Therefore, the HEER Office will accept results from uncertified laboratories, with documentation, until such time that this program may be fully implemented by the State of Hawaii.

4.11 Equipment Decontamination and Disposal

Sampling equipment should never be reused without first being decontaminated.

The following is a recommended generic procedure for decontamination of sampling equipment:

1. Wash with non-phosphate detergent
2. Tap-water rinse
3. 0.1N nitric acid rinse (when cross-contamination from metals is a concern)
4. Deionized/distilled water rinse
5. Pesticide grade solvent rinse (when semivolatile and non-volatile organic contamination may be present)
6. Deionized/distilled water rinse (twice; once if Step 5 is not needed)
7. Organic free water rinse (HPLC grade)

The above procedure is not appropriate for every field situation. However, the procedure selected must be clearly documented in the Field Sampling Plan.

The FSP must also describe how drilling equipment will be decontaminated prior to each boring.

Whenever possible, obtain sets of sampling tools so that decontamination can be done in batches, preferably just once a day at the start or end of a sampling day to minimize the number of blanks needed.

It is the responsibility of the party conducting the sampling to properly dispose of all waste generated according to local, state, and federal regulations.

4.12 Management of Investigation Derived Waste

In the process of collecting environmental samples, potentially contaminated investigation-derived waste (IDW) is generated. This includes soil, groundwater, used personal protective equipment, and decontamination fluids.

IDW is identified by the following: type of IDW (such as soil cutting, ground water, decon fluids, etc.); characteristics (Hazardous Waste or Non-hazardous Waste); and quantity of waste.

If the IDW is non-hazardous soil or water, it should be left onsite. The following are options for handling non-hazardous IDW:

For soil cuttings:

- Spread around the well
- Put back to the boring
- Put into a pit within an area of concern
- Dispose of at an on-site Disposal Unit

For ground water

- Pour onto ground next to the well to allow infiltration
- Dispose of at an on-site temporary disposal unit

For decontamination fluids

- Pour onto ground (from containers) to allow infiltration
- Dispose of at an on-site temporary disposal unit

For decontaminated PPE and DE

- Double bag and deposit in the site dumpster, or a municipal landfill
- Dispose of at an on-site temporary disposal unit

Hazardous waste may be left on-site, if they are within an area of contamination. If IDW are considered hazardous and are determined to pose no immediate threat to human health and the environment, the wastes may be left on site within a secure delineated area of contamination.

However, before deciding to leave hazardous soil on site, the proximity of residents and workers in the surrounding area must be considered. Planning to leave hazardous waste on site involves:

1. Delineating the AOC;
2. Determining pit locations close to borings within the AOC unit for waste burial
3. Covering IDW in the pits with surficial soil;
4. Not containerizing and testing wastes designated to be left on site.

Another alternative for leaving hazardous soil is disposal in a temporary disposal unit located on the same property as the AOC under investigation.

IDW should be disposed of off site if the following is true:

1. Hazardous water;
2. Hazardous soil that poses a risk if left at the site;
3. Hazardous PPE and DE;
4. If leaving on site would increase risks at the site.

IDW designated for off site disposal must be tested, properly containerized, and stored before pick up and disposal. RCRA regulations must be followed. This usually entails a TCLP if the waste is suspected of being hazardous waste.

Section 4

APPENDICES

Target Compound List

Suggested Report Formats

Work Plan

Quality Assurance Project Plan

Field Sampling Plan

Recommended Sample Control Procedures

Section 4

Appendix 4A

Target Compound List

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

| | <u>Volatiles</u> | <u>CAS No.</u> | <u>Quantitation Limit¹</u> | | |
|-----|----------------------------|----------------|---------------------------------------|---|--|
| | | | <u>Water</u> <u>µg/L</u> | <u>Low</u> <u>Soil</u> <u>µg/Kg</u> | <u>Med.</u> <u>Soil</u> <u>µg/Kg</u> |
| 1. | Chloromethane | 74-87-3 | 10 | 10 | 1200 |
| 2. | Bromomethane | 74-83-9 | 10 | 10 | 1200 |
| 3. | Vinyl Chloride | 75-01-4 | 10 | 10 | 1200 |
| 4. | Chloroethane | 75-00-3 | 10 | 10 | 1200 |
| 5. | Methylene Chloride | 75-09-2 | 10 | 10 | 1200 |
| 6. | Acetone | 67-64-1 | 10 | 10 | 1200 |
| 7. | Carbon Disulfide | 75-15-0 | 10 | 10 | 1200 |
| 8. | 1,1-Dichloroethene | 75-35-4 | 10 | 10 | 1200 |
| 9. | 1,1-Dichloroethane | 75-34-3 | 10 | 10 | 1200 |
| 10. | 1,2-Dichloroethene (Total) | 540-59-0 | 10 | 10 | 1200 |
| 11. | Chloroform | 67-66-3 | 10 | 10 | 1200 |
| 12. | 1,2-Dichloroethane | 107-06-2 | 10 | 10 | 1200 |
| 13. | 2-butanone | 78-93-3 | 10 | 10 | 1200 |
| 14. | 1,1,1-Trichloroethane | 71-55-6 | 10 | 10 | 1200 |
| 15. | Carbon Tetrachloride | 56-23-5 | 10 | 10 | 1200 |
| 16. | Bromodichloromethane | 75-27-4 | 10 | 10 | 1200 |
| 17. | 1,2-Dichloropropane | 78-87-5 | 10 | 10 | 1200 |
| 18. | cis-1,3-Dichloropropene | 10061-01-5 | 10 | 10 | 1200 |
| 19. | Trichloroethene | 79-01-6 | 10 | 10 | 1200 |
| 20. | Dibromochloromethane | 75-27-4 | 10 | 10 | 1200 |
| 21. | 1,1,2-Trichloroethane | 79-00-5 | 10 | 10 | 1200 |
| 22. | Benzene | 71-43-2 | 10 | 10 | 1200 |
| 23. | trans-1,3-Dichloropropene | 10061-02-6 | 10 | 10 | 1200 |
| 24. | Bromoform | 75-25-2 | 10 | 10 | 1200 |
| 25. | 4-Methyl-2-pentanone | 108-10-1 | 10 | 10 | 1200 |
| 26. | 2-Hexanone | 591-78-6 | 10 | 10 | 1200 |
| 27. | Tetrachloroethene | 127-18-4 | 10 | 10 | 1200 |
| 28. | Toluene | 108-88-3 | 10 | 10 | 1200 |
| 29. | 1,1,2,2-Tetrachloroethane | 79-34-5 | 10 | 10 | 1200 |
| 30. | Chlorobenzene | 108-90-7 | 10 | 10 | 1200 |
| 31. | Ethyl Benzene | 100-41-4 | 10 | 10 | 1200 |
| 32. | Styrene | 100-42-5 | 10 | 10 | 1200 |
| 33. | Xlyenes (Total) | 1330-20-7 | 10 | 10 | 1200 |

¹Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

| | <u>Semivolatiles</u> | <u>CAS No.</u> | <u>Quantitation Limit¹</u> | | |
|-----|---|----------------|---------------------------------------|---|--|
| | | | <u>Water</u> <u>µg/L</u> | <u>Low</u> <u>Soil</u> <u>µg/Kg</u> | <u>Med.</u> <u>Soil</u> <u>µg/Kg</u> |
| 34. | Phenol | 108-95-2 | 10 | 330 | 10000 |
| 35. | bis(2-chloroethyl)ether | 111-44-4 | 10 | 330 | 10000 |
| 36. | 2-chlorophenol | 95-57-8 | 10 | 330 | 10000 |
| 37. | 1,3-Dichlorobenzene | 541-73-1 | 10 | 330 | 10000 |
| 38. | 1,4-Dichlorobenzene | 106-46-7 | 10 | 330 | 10000 |
| 39. | 1,2-Dichlorobenzene | 95-50-1 | 10 | 33 | 10000 |
| 40. | 2-methylphenol | 95-48-7 | 10 | 330 | 10000 |
| 41. | 2,2'-oxybis(1-chloropropane) ² | 108-60-1 | 10 | 330 | 10000 |
| 42. | 4-Methylphenol | 106-44-5 | 10 | 330 | 10000 |
| 43. | N-Nitroso-di-n-propylamine | 621-64-7 | 10 | 330 | 10000 |
| 44. | Hexachloroethane | 67-72-1 | 10 | 330 | 10000 |
| 45. | Nitrobenzene | 98-95-3 | 10 | 330 | 10000 |
| 46. | Isophorone | 78-59-1 | 10 | 330 | 10000 |
| 47. | 2-Nitrophenol | 88-75-5 | 10 | 330 | 10000 |
| 48. | 2,4-Dimethylphenol | 105-67-9 | 10 | 330 | 10000 |
| 49. | bis(2-Chloroethoxy)-methane | 111-91-1 | 10 | 330 | 10000 |
| 50. | 1,2-Dichloropropane | 120-83-2 | 10 | 330 | 10000 |
| 51. | 1,2,4-Trichlorobenzene | 120-82-1 | 10 | 330 | 10000 |
| 52. | Naphthalene | 91-20-3 | 10 | 330 | 10000 |
| 53. | 4-Chlorophenol | 106-47-8 | 10 | 330 | 10000 |
| 54. | Hexachlorobutadiene | 87-68-3 | 10 | 330 | 10000 |
| 55. | 4-Chloro-3-methyl-phenol | 59-50-7 | 10 | 330 | 10000 |
| 56. | 2-Methylnaphthalene | 91-57-6 | 10 | 330 | 10000 |
| 57. | Hexachlorobutadiene | 77-47-4 | 10 | 330 | 10000 |
| 58. | 2,4,6-Trichlorophenol | 88-06-2 | 10 | 330 | 10000 |
| 59. | 2,4,5-Trichlorophenol | 95-95-4 | 25 | 800 | 25000 |
| 60. | 2-Chloronaphthalene | 91-58-7 | 10 | 330 | 10000 |
| 61. | 2-Nitroaniline | 88-74-4 | 25 | 800 | 25000 |
| 62. | Dimethylphthalate | 131-11-3 | 10 | 330 | 10000 |
| 63. | Acenaphthylene | 208-96-8 | 10 | 330 | 10000 |
| 64. | 2,6-Dinitrotoluene | 606-20-2 | 10 | 330 | 10000 |
| 65. | 3-Nitroaniline | 99-09-2 | 25 | 800 | 25000 |

²Previously known by the name bis(2-chloroisopropyl)ether.

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

| | <u>Semivolatiles</u> | <u>CAS No.</u> | <u>Quantitation Limit¹</u> | | |
|-----|----------------------------|----------------|---------------------------------------|---|--|
| | | | <u>Water</u> <u>µg/L</u> | <u>Low</u> <u>Soil</u> <u>µg/Kg</u> | <u>Med.</u> <u>Soil</u> <u>µg/Kg</u> |
| 66. | Acenaphthene | 83-32-9 | 10 | 330 | 10000 |
| 67. | 2,4-Dinitrophenol | 51-28-5 | 25 | 800 | 25000 |
| 68. | 4-Nitrophenol | 100-02-7 | 25 | 800 | 25000 |
| 69. | Dibenzofuran | 132-64-9 | 10 | 330 | 10000 |
| 70. | 2,4-Dinitrotoluene | 121-14-2 | 10 | 330 | 10000 |
| 71. | Diethylphthalate | 84-66-2 | 10 | 330 | 10000 |
| 72. | 4-Chlorophenyl-phenylether | 7005-72-3 | 10 | 330 | 10000 |
| 73. | Fluorene | 86-73-7 | 10 | 330 | 10000 |
| 74. | 4-Nitroaniline | 100-01-6 | 25 | 800 | 25000 |
| 75. | 4,6-Dinitro-2-phenol | 534-52-1 | 25 | 800 | 25000 |
| 76. | N-Nitrosodiphenyl-amine | 86-30-6 | 10 | 330 | 10000 |
| 77. | 4-Bromophenyl-phenylether | 101-55-3 | 10 | 330 | 10000 |
| 78. | Hexachlorobenzene | 118-74-1 | 10 | 330 | 10000 |
| 79. | Pentachlorophenol | 87-86-5 | 25 | 800 | 25000 |
| 80. | Phenanthrene | 85-01-8 | 10 | 330 | 10000 |
| 81. | Anthracene | 120-12-7 | 10 | 330 | 10000 |
| 82. | Carbazole | 86-74-8 | 10 | 330 | 10000 |
| 83. | Di-n-Butylphthalate | 84-74-2 | 10 | 330 | 10000 |
| 84. | Fluoranthene | 206-44-0 | 10 | 330 | 10000 |
| 85. | Pyrene | 129-00-0 | 10 | 330 | 10000 |
| 86. | Butylbenzylphthalate | 85-68-7 | 10 | 330 | 10000 |
| 87. | 3,3'-Dichloro-benzidine | 91-94-1 | 10 | 330 | 10000 |
| 88. | Benzo(a)anthracene | 56-55-3 | 10 | 330 | 10000 |
| 89. | Chrysene | 218-01-9 | 10 | 330 | 10000 |
| 90. | bis(2-Ethylhexyl) | 117-81-7 | 10 | 330 | 10000 |
| 91. | Di-n-octylphthalate | 117-84-0 | 10 | 330 | 10000 |
| 92. | Benzo(b)fluoranthene | 205-99-2 | 10 | 330 | 10000 |
| 93. | Benzo(k)fluoranthene | 207-08-9 | 10 | 330 | 10000 |
| 94. | Benzo(a)pyrene | 50-32-8 | 10 | 330 | 10000 |
| 95. | Indeno(1,2,3-cd)-pyrene | 193-39-5 | 10 | 330 | 10000 |
| 96. | Dibenz(a,h)anthracene | 53-70-3 | 10 | 330 | 10000 |
| 97. | Benzo(g,h,i)perylene | 191-24-2 | 10 | 330 | 10000 |

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

| | | | <u>Quantitation Limit¹</u> | |
|------|-----------------------------|----------------|---------------------------------------|----------------------|
| | <u>Pesticides/Arochlors</u> | <u>CAS No.</u> | Water <u>µg/L</u> | Soil <u>µg/Kg</u> |
| 98. | alpha-BHC | 319-84-6 | 0.05 | 1.7 |
| 99. | beta-BHC | 319-84-6 | 0.05 | 1.7 |
| 100. | delta-BHC | 319-86-8 | 0.05 | 1.7 |
| 101. | gamma-BHC(Lindane) | 58-89-9 | 0.05 | 1.7 |
| 102. | Heptachlor | 76-44-8 | 0.05 | 1.7 |
| 103. | Aldrin | 309-00-2 | 0.05 | 1.7 |
| 104. | Heptachlor epoxide | 1024-57-3 | 0.05 | 1.7 |
| 105. | Endosulfan I | 959-98-8 | 0.05 | 1.7 |
| 106. | Dieldrin | 60-57-1 | 0.10 | 3.3 |
| 107. | 4,4'-DDE | 72-55-9 | 0.10 | 3.3 |
| 108. | Endrin | 72-20-8 | 0.10 | 3.3 |
| 109. | Endosulfan II | 33213-65-9 | 0.10 | 3.3 |
| 110. | 4,4'DDD | 72-54-8 | 0.10 | 3.3 |
| 111. | Endosulfan sulfate | 1031-07-8 | 0.10 | 3.3 |
| 112. | 4,4'DDT | 50-29-3 | 0.10 | 3.3 |
| 113. | Methoxychlor | 72-43-5 | 0.50 | 17.0 |
| 114. | Endrin ketone | 53494-70-5 | 0.10 | 3.3 |
| 115. | Endrin aldehyde | 7421-36-3 | 0.10 | 3.3 |
| 116. | alpha-chlordane | 5103-71-9 | 0.05 | 1.7 |
| 117. | gamma-chlordane | 5103-74-2 | 0.05 | 1.7 |
| 118. | Toxaphene | 8001-35-2 | 5.0 | 170.0 |
| 119. | Arochlor-1016 | 12674-11-2 | 1.0 | 33.0 |
| 120. | Arochlor-1221 | 11104-28-2 | 2.0 | 67.0 |
| 121. | Arochlor-1232 | 11141-16-5 | 1.0 | 33.0 |
| 122. | Arochlor-1242 | 53469-21-9 | 1.0 | 33.0 |
| 123. | Arochlor-1248 | 12672-29-6 | 1.0 | 33.0 |
| 124. | Arochlor-1254 | 11097-69-1 | 1.0 | 33.0 |
| 125. | Arochlor-1260 | 11096-82-5 | 1.0 | 33.0 |

There is no differentiation between the preparation of low and medium soil samples in this method for the analysis of Pesticides/Arochlors

INORGANIC TARGET ANALYTE LIST (TAL)

| <u>Analyte</u> | <u>Contract Required Detection Limits³ (μg/L)</u> |
|----------------|---|
| Aluminum | 200 |
| Antimony | 60 |
| Arsenic | 10 |
| Barium | 200 |
| Beryllium | 5 |
| Cadmium | 5 |
| Calcium | 5000 |
| Chromium | 10 |
| Cobalt | 50 |
| Copper | 25 |
| Iron | 100 |
| Lead | 3 |
| Magnesium | 5000 |
| Manganese | 15 |
| Mercury | 0.2 |
| Nickel | 40 |
| Potassium | 5000 |
| Selenium | 5 |
| Silver | 10 |
| Sodium | 5000 |
| Thallium | 10 |
| Vanadium | 50 |
| Zinc | 20 |
| Cyanide | 10 |

3Higher detection limits may only be used in the following circumstance:

If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the contract Required Detection Limit. This is illustrated in the example below:

For Lead:

Method in use- ICP

Instrument Detection Limit (IDL)- 40

Sample concentration- 220

Contract Required Detection Limit (CRDL)- 3

Section 4

Appendix 4B

Suggested Report Formats

Section 4

Appendix 4B

Suggested Format For A Workplan

SUGGESTED FORMAT FOR A WORK PLAN

I GENERAL INFORMATION

Name and address of facility

Area Map showing facility location relative to nearby landmarks such as ocean, streams, roads, parks, commercial/industrial areas, etc. Within 1/4 mile radius of the site, show location of public and private drinking water wells, irrigation wells, and underground injection wells. Indicate map orientation with North directional arrow.

Site map showing details of the following (if known):

Types and volumes of waste present at site

Underground tanks and piping locations (or previous locations, if removed)

Storm drains, sewer and electrical lines

Septic tanks, cesspools, and leach fields

Building structures, including locations of demolished structures

Property boundaries

Chemical storage, transfer, and holding areas

Location of areas where current or past commercial/industrial activities are or have taken place (e.g. washout areas, sumps, trenches, injection wells, pits, ponds, lagoons, dumping grounds, etc.)

Description of local topography, geology, nearby water bodies, flora/fauna, and estimated/measured depth to groundwater.

Description of current and past site uses and any commercial/industrial activities which are or have occurred at the site. Identify chemical or petroleum substances and any estimate of quantities released.

Description of population and land use(s) of surrounding area.

List and summaries of all existing environmental information pertaining to the facility including results of record search, industrial accidents, environmental assessments, etc.

II PURPOSE AND SCOPE OF PROPOSED WORK

Discussion of how this proposed work plan is intended to fit in with other phases of environmental work to be performed, or planned for in the future, if any. Include a discussion of the technical approach used or proposed to be used for this phase of work.

Discussion of any or all of the following purposes for this proposed work plan which may be applicable:

- Record Search

- Preliminary site assessment

- Emergency response and release abatement

- Contaminated soil investigation

- Contaminated soil remediation

- Contaminated groundwater investigation

- Contaminated groundwater remediation

- Soil and/or Groundwater sampling

Discussion of conditions under which this proposed work plan may not be followed.

Description of how the work plan may be modified accordingly.

III SCHEDULE OF PROPOSED ACTIVITIES

The work plan schedule should include a description of milestone tasks to be completed. Provide dates for start and completion of each task with any interim dates for progress reports. Include a time period for data review and a due date(s) for final report(s). For multiple task work plans, include a diagram, flow chart, or critical path chart to help readers to understand the schedule of work activities planned.

IV STATEMENT OF INTENDED DATA USAGE

If the proposed work plan includes the procurement of environmental data, define the types of environmental decisions to be made, identify the intended uses of the data (i.e., define the data quality objectives), and design and

appropriate data collection program. The data quality objectives dictate the level of detail required in the Field Sampling and Quality Assurance Project Plan which may be integral parts of this proposed work plan. The following are examples of possible uses of environmental data, and any one or combination may be intended uses for a proposed work plan:

- Confirm suspected contaminants or concentration of contaminants

- Qualitatively assess the nature and extent of contamination

- Design subsequent sampling events

- Implement emergency response and release abatement actions.

- Compare containment concentrations found with established criteria

- Assess exposure, endangerment, and risks

- Screen or select clean up alternatives

- Use as input to conceptual design of clean up technologies and methods

- Use in documenting residual contaminants, if any, upon completion of response action.

V. DESCRIPTION OF PROPOSED ACTIVITIES

Give complete descriptions of all major tasks planned. Indicate incremental steps necessary to accomplish each task.

- For record search tasks, identify possible sources for information and how the information will be obtained.

- Potential pathways of contaminant migration/preliminary public health and environmental impacts

- Preliminary identification of response action objectives and response action alternatives

- Preliminary site assessment tasks, describe logistics of the site visit, inspection and data gathering protocol, and extent of any environmental measurements to be taken.

- For emergency response and release abatement tasks, describe situations anticipated, equipment and materials needed, and procedures

to be followed.

For soil and/or groundwater investigative tasks, include (or reference) a Field Sampling Plan and Quality Assurance Project Plan developed to the appropriate level of detail commensurate with the data quality objectives for the sampling event.

For clean up tasks, identify clean up objectives and remediation technologies and methods to be employed on site and off site. For off site remediation, include a copy, or reference, and Operations manual for the process. Include a clean up plan to monitor and report to the HEER Office the effectiveness of the technology and methods employed.

Data Quality Objectives requiring known, defensible data quality for sound decisions making purposes mandate that an adequate Field Sampling Plan and an adequate Quality Assurance Project Plan be developed and followed.

Data Quality Objectives for tasks such as screening, scoping, or qualitatively assessing a site for contaminants do not necessitate a rigorous Field Sampling Plan or Quality assurance Project Plan.

Provide supporting rational for all data collection tasks. Five reasons for measuring specific contaminants. Give reasons for measuring contaminants at specific sampling locations.

Provide and accounting of costs and key assumptions for determining costs.

VI DOCUMENTATION AND REPORTING

Observation and details on how each task in the proposed work plan was accomplished should be carefully noted in a daily field log book.

Upon completion of the tasks in the work plan, specify that a data report will be prepared for submittal to the HEER Office which describes the work performed, presents the data findings, gives conclusions, and sets forth recommendations.

To the extent possible, at this point in the response action, specify that appropriate information and reports will be prepared for submittal to the HEER Office.

VII QUALIFICATION OF ENVIRONMENTAL PERSONNEL

Provide a list of all persons by name, title, and company affiliation who will be performing the tasks set forth in this proposed work plan.

Provide a description of the duties and responsibilities of each person with respect to the work plan tasks.

Provide the qualifications of each person listed including education, experience and training.

Provide a project organizational diagram of all persons, including consultants and contractors.

Provide the name and telephone number for one person designated as the Project Coordinator responsible for the day-to-day response activities for carrying out this work plan.

Appendix 4B

Suggested Format for a Quality Assurance Project Plan



SUGGESTED FORMAT FOR A QUALITY ASSURANCE PROJECT PLAN

I TITLE PAGE

At the bottom of the title page, provide signature blocks for approval of the Quality Assurance Project Plan (QAPP). If the owner or operator of the project has a designated head of environmental matters, then that person should approve of the QAPP. If the owner or operator has hired an environmental consultant or contractor for the investigative or sampling event, then the consultant's or contractor's project manager and quality assurance manager should approve the QAPP. If a subcontractor is also used, then the approval of the subcontractor's project manager and quality assurance manager should also be obtained. Finally, the director of the designated laboratory should approve the QAPP.

II TABLE OF CONTENTS

Include the following sections in the Table of Contents:

Introduction and Project Description

Project Organization and Responsibilities

Quality Assurance Objectives for Data Measurements

Sampling Procedures

Sampling and Document Custody Procedures

Calibration Procedure and Frequency

Sample Preparation and Analytical Procedures

Data Reduction and Validation

Internal Quality Control Checks

Performance and Systems Audits

Preventative Maintenance

Data Measurement Assessment Procedures

Corrective Actions

Quality Assurance Reports to Management

List of Appendices

III INTRODUCTION AND PROJECT DESCRIPTION

The introduction to the project description section should consist of a general paragraph identifying the phase of the work and the general objectives of the investigation.

In describing the investigative project, include a description of the location, size and important physical features of the site, such as ponds, lagoons, streams and roads. Include a drawing showing site locations and layout. Provide a chronological site history including descriptions of the use of the site, complaints by neighbors, construction and environment permits, and chemical usage. Also provide a brief summary of previous investigative or sampling efforts and an overview of the results. Finally, list specific project objectives for this particular phase of data gathering, and identify ways in which the data will be used to address each of the objectives. Identify matrix groups and parameters of interest.

IV. PROJECT ORGANIZATION AND RESPONSIBILITIES

Identify key personnel or organizations that are necessary for each activity during the sampling event. Provide a description of responsibilities for each. Include a table or a chart which shows the organization and line of authority for decisions making. Where specific personnel cannot yet be identified, list the job title and the representative organization charged with that responsibility.

V QUALITY ASSURANCE OBJECTIVES FOR DATA MEASUREMENT

For individual matrix groups and parameters, implement a multiple party cooperative effort to include the owner/operator of the property, the consultant/contractor, subcontractors, and representative of the designated laboratory in order to define what levels of quality are required for the data (Data Quality Objectives). These quality assurance (QA) objectives will be based on a common understanding of the intended use of the data, available laboratory procedures, available resources, and logistical limitations, (if any). Itemize the field blanks and duplicate field sample aliquots to be collected for QA purposes for the matrix groups identified in the project Description.

The selection of analytical methods require a familiarity with regulatory or legal requirements concerning data usage. Provide descriptions of any sample preparation and analytical methods to be used. These may be appended to this QAPP document. If particular standard testing methods are preferred by the

HEER Office and those methods are deemed to be appropriate and are planned to be used, then these methods can simply be referenced.

Review the detection limits needed for the project as compared to the detection limits of methods offered by the designated laboratory. Pay special attention to detection limits provided by the laboratory for volatile organic compounds because these limits are often found to be insufficient for the analysis of water for drinking water standards or other requirements.

Establish quantitative limits of the following QA objectives:

- Level of QA effort

- Accuracy of spikes, reference compounds, etc.

- Precision

- Method detection limits

While planning for the sampling event, take into consideration the quality characteristics of completeness, representativeness, and comparability. Laboratories should provide data that meet quality control acceptance criteria for 90 percent or more of the requested determinations. Identify any sample types, such as control or background locations, that require a higher degree of completeness.

Representativeness of the data is most often thought of in terms of collection of representative samples or selection of representative sample aliquots during laboratory analysis. Comparability is a consideration during the planning stage to avoid having to use data gathered by different organization or among different analytical methods that cannot be reasonably compared because of differences in sampling conditions, sampling procedures, etc.

VI SAMPLING PROCEDURES

These procedures may be appended to the site specific Sampling Plan. Documentation for field measurements or test procedure for hydro geological investigations should be located in either the Sampling Plan or the "Sample Preparation and Analytical Procedure" section of the QAPP.

Provide a description of the sample procedures to be used for each major measurement, including pollutant measurement systems. Where applicable, the following items should be included:

- A description of techniques or guidelines used to select sampling sites

A description of the specific sampling procedures to be used

Charts, flow diagrams, or tables delineating sample program operations

A description of containers, procedures, reagents, etc. used for sample collection, preservation, transport, and storage.

A discussion of special conditions for the Preparation of sampling equipment and containers to avoid sample contamination

A description of sample preservation methods

A discussion of the time considerations for shipping samples promptly to the laboratory (i.e., holding times)

Examples of the custody or chain of custody procedures and forms

A description of the forms, notebooks, and procedures to be used to record sample history, sampling conditions, and analysis to be performed

Data quality objectives may be incorporated by reference in this section. Also append any special field operation methods or procedures which may be routinely used.

VII SAMPLE AND DOCUMENT CUSTODY PROCEDURES

Sample custody is part of any good laboratory or field operation. If sampling data are needed to demonstrate compliance with specific requirements or if the data may be used for legal purposes, then use chain of custody procedures. The topic of custody may be divided into three basic areas:

Sample collection

Laboratory

Final evidence files

Address all three areas of custody in the QAPP. The owner/operator or the environmental consultant/contractor may refer to other guidance documents for additional information on this topic, such as EPA's "CLP User's Guide." Include all originals of laboratory reports in the final evidence files. Maintain these files under custody.

A sample or an evidence file is under custody if:

It is in your possession;

It is in your view, after being in your possession;

It was in your possession and you placed it in secure area; and

It is in a designated secure area.

Provide examples of chain of custody records or forms to be used to record the chain of custody for samples, laboratories, and evidence files.

VIII CALIBRATION PROCEDURES AND FREQUENCY

Identify calibration procedures and frequency for each parameter measured and include field and laboratory testing. The appropriate standard operating procedures (SOP) can be appended and referenced, or a written description of the calibration procedures to be used must be provided.

IX SAMPLE PREPARATION AND ANALYTICAL PROCEDURES

For each measurement, either append and reference the applicable analytical SOP or provide a written description of sample preparation and analytical procedures. Standard EPA test methods are preferred, and simple references to them are sufficient.

X DATA REDUCTION AND VALIDATION

For each measurement, describe the data reduction scheme planned for the collected data, including all equations used to calculate the concentrations or value of the measured parameter. Specify the criteria that will be used to validate the integrity of the data during collection and reporting. For additional information on data validation, refer to EPA's documents entitled, "Functional Guidelines for Evaluating Organic Analysis (EPA 68-01-6699)" or "Functional Guidelines for Evaluating Inorganic Analysis."

XI. INTERNAL QUALITY CONTROL CHECKS

Identify all specific internal quality control methods to be used. These methods include the use of replicates, spike samples, split samples, blanks, standards, and QC samples. Identify the ways in which the quality control information will be used to qualify the data.

XII. PERFORMANCE AND SYSTEM AUDITS

Describe the internal and external performance and systems audits that will be

implemented to monitor the capability and performance of the total measurement system. Additional information on this topic may be found in EPA's "Compendium of Superfund Field Operations Methods" for routine field work.

The systems audits consists of evaluating the components of the measurement systems to determine their proper selection and use. These audits include a careful evaluation of both field and laboratory quality control procedures and are normally performed before or shortly after systems are operational. However, such audits should be performed on a regular schedule over the duration of an investigation or over continuing periods of operation. (Formal laboratory certification programs require onsite systems audit.)

After systems are operational and are generating data, performance audits are conducted periodically to determine the accuracy of the total measurement system or its component parts. Include a schedule for conducting performance audits for each measurement parameter.

XIII PREVENTATIVE MAINTENANCE

Provide a schedule of the major preventative maintenance tasks that will be carried out to minimize downtime of field and laboratory instruments, and equipment. References can be made to owner's manuals for specific field equipment.

XIV DATA MEASUREMENT ASSESSMENT PROCEDURES

This section describes specific routine procedures which will be used to assess data (i.e., to assess data for precision, accuracy, and completeness). The precision and accuracy of data must be routinely assessed for all environmental monitoring and measurement data. Describe specific procedures to be employed to accomplish this assessment. If enough data are generated, statistical procedures may be used to assess the precision, accuracy, and completeness. If statistical procedures are used, they must be documented.

XV. CORRECTIVE ACTIONS

In the context of quality assurance, corrective actions are procedures that might be implemented with respect to samples that do not meet QA specifications. Corrective action are usually addressed on a case by case basis for a specific investigation. The need for corrective actions is based on predetermined limits of acceptability. Corrective actions may include resampling or reanalysis of samples and recommending an audit of laboratory procedures. Identify persons responsible for initiating these actions, procedures for identifying and documenting corrective action, and reporting and follow up procedures.

XVI QUALITY ASSURANCE REPORTS TO MANAGEMENT

Identify the method to be used to report the performance of measurement systems and data quality. In these reports, include results of performance audits, results of systems audits, and significant QA problems encountered, along with recommended solutions. The final report for each investigation must include a separate QA section that summarizes the data quality information contained in periodic reports.

Appendix 4B

Suggested Format for a Field Sampling Plan

SUGGESTED FORMAT FOR A FIELD SAMPLING PLAN

I SITE BACKGROUND

Analyze all existing data and summarize the information here. Include a description of the site and surrounding areas and a discussion of known or suspected contaminant sources, probable transport pathways, and other information about the site. Also include a description of specific data gaps and information about the site. Also include a description of specific data gaps and ways in which this sampling scheme is designed to fill those gaps.

II SAMPLING OBJECTIVES

Clearly specify the objectives of the sampling effort. Specify the intended uses of the data (Data Quality Objectives). This should be clearly and succinctly stated. Give supporting rationale for the representation of the data to be procured.

III SAMPLE LOCATION AND FREQUENCY

This section of the Sampling Plan identifies each sample matrix to be collected and the constituents to be analyzed. Use a table to clearly identify the number of samples to be collected along with the appropriate number of replicates and blanks. Include a drawing to show the locations of existing or proposed sample points. If applicable, specify frequency of sampling.

IV SAMPLE DESIGNATION

Establish a sample numbering system for each investigation project. The sample designation should include the sample or well number, the sampling round, the sample matrix (e.g., surface soil, groundwater, soil boring), and the name of the site.

V. SAMPLING EQUIPMENT AND PROCEDURES

Sampling procedures must be clearly written. Step-by-step instructions for each type of sampling are necessary to enable the field team to gather data that will meet the data quality objectives established. Include a list of instruments, and equipment to be used including a description of the material of construction (e.g., Teflon, stainless steel, PVC) for the equipment.

VI SAMPLE HANDLING AND ANALYSIS

Include a table that identifies sample preservation methods, types of sampling containers, shipping requirements, and holding times.

Include examples of paperwork and instructions for filling out the paperwork (e.g., traffic reports, chain of custody forms, packaging lists, and sample tags to be filled out for the samples). Include examples and instructions for filling out any other specific documentation that the designated laboratory will require.

Provide for proper handling and disposal of wastes generated at the site as a result of the sampling event. Describe site-specific procedures to prevent contamination of clean areas and to comply with existing requirements. Include instructions to clearly document actions taken.

Appendix 4C

Recommended Sample Control Procedures

RECOMMENDED SAMPLE CONTROL PROCEDURES

GENERAL

This section outlines the acceptable procedures governing the control of samples. In order for samples to be properly controlled, they must first be identified properly. Appropriate sample identification procedures are discussed in this section. Samples must be adequately contained and transmitted from the primary site investigator through an unbroken chain of custody process to the analytical laboratory manager and the analytical chemist. Proper containment and preservation of samples are also discussed in this section. The shipment and chain of custody process are described, as well as procedures for documentation of sample control for data defensibility.

SAMPLE IDENTIFICATION

The procedures described here are for Definitive Data Collection and data handling. These procedures may be modified accordingly by the primary site investigatory on a site specific basis.

Sample Identification Tags

Each sample collected in the field will be identified with a sample identification tag. The sample identification tag:

1. Serial tag Number: The tag should have a unique stamped serial number. This should be recorded in the field notebook.
2. Event Code: The event code is a unique number assigned by the primary site investigator for each site and sampling event.
3. Date: State the date the sample was collected. All dates are expressed as YYMMDD, where YY refers to the two-digit year code, MM refers to the two-digit month code, and DD refers to the two-digit day code for the month. So that data may be chronologically sequenced in a database file without errors, it is imperative that the full two-digit day code be used.
4. Time: The time the sample was collected is entered on the sample identification tag. All times are expressed as four digit number indicating the time of collection using 24 hour clock noting Hawaii Standard Time (HST).
5. Station number: The station number is the unique sampling point identification number assigned to each sampling location during preparation of the site specific sampling plan.

6. Station location: The sampling location identification is the sampling plan at which the sample was procured is described on the sample tag.
7. Preservation: If a chemical preservation was used, the type and quantity of preservative added to the sample is written on the sample tag.
8. Grab/composite sample: Indicate on the sample tag if the sample is a grab sample or a composite sample.
9. Analysis Requested: Indicate the type of analysis requested for the sample.
10. Sampling personnel: The printed name and signature of each person who collected the sample is included on the sample tag.
11. Field Sample ID Number: A unique number identifying the sample in sequence of collection at the station location.
12. Laboratory Sample ID Number: A space on the sample tag is reserved for laboratory use to record the laboratory sample number.
13. Remarks: Any pertinent information such as identification of split samples or special procedures is included on the sample tag.

SAMPLE CONTAINERS

Primary Containers

Primary sample containers are those that contain the material for analysis. The site specific sampling plan identifies the sample containers to be used for samples collected for each of the analyses to be performed. The materials of construction, volume, source, and grade of the sample containers are also specified. The quantity of sample bottles provided for a sampling event should always exceed the required number of sample bottles by 50 percent, in case of accidents or so that additional samples can be taken if desired. The table lists appropriate sample containers for the different types of media and analyses commonly required for contaminated sites.

Secondary and tertiary containers for higher degrees of analytical support are discussed below. These procedures should only be used in site specific cases as required by the site investigator.

Secondary Containers

Primary sample containers (such as samples collected for volatile organic analyses) may require secondary containment for protection of the sample container and to

eliminate the possibility of cross contamination. Secondary containers (plastic bags, metal cans, etc.) should have an appropriate packing material and be secured with a custody seal. If appropriate, the primary site investigator will consider the need for travel blanks).

Tertiary Containers

Samples to be shipped to the analytical laboratory will be placed in tertiary containers (coolers, shipping containers, etc.). The tertiary containers are padlocked or sealed with custody seals. If custody seals are used, a minimum of two custody seals will be placed on each shipping container with at least one at the front and one at the back. These custody seals are located in a manner which would indicate container tampering. Wide, clear tape is placed over the seals to ensure that the seals are not broken during transit. As above, the primary site investigator will consider the need for travel blanks.

| TPH, BTEX, Purgeable HC, Organolead - soil | 3" stainless steel or brass cylinder | 14 days | 4°C |
|---|---|---------|-----|
| TPH, BTEX, Purgeable HC, and Organolead - water | 40 ml glass vial, Teflon faced silicon septum | 14 days | 4°C |
| PAH, PCB - soil | 8 oz, wide mouth glass with Teflon liner | 14 days | 4°C |
| PAH, PCB - water | 1000 ml amber glass with Teflon liner | 7 days | 4°C |

SAMPLE PRESERVATION

After samples have been contained, and depending on the level of analytical support and type of analyses required as specified in the site specific sampling plan, appropriate preservation techniques will be used. Sample preservation ensures that no physical/chemical changes to the sample occur prior to workup, extraction and/or analysis at the laboratory. Both temperature and light can be significant sources of error in the sampling and analysis process. Adequate controls for these sources of error, such as storing the samples in dark, cold container, are also specified in the sampling plan.

¹Holding times are for sample. Holding times for some extracts may be longer.

CHAIN OF CUSTODY

Chain of custody is the process by which authorized control of a sample is successively transferred from one person to another by the use of approved procedures and documents. If sample integrity is to be defensible, chain of custody procedures are necessary to document handling of samples from procurement through final analysis and disposition.

A sample is considered to be under a person's custody if:

The sample is in the person's physical possession.

The sample is in view of the person after that person has taken possession.

The sample is secured by that person so that no one can tamper with the sample.

The sample is secured by that person in an area which is restricted to authorized personnel.

Field samplers are personally responsible for the care and custody of the samples collected by their teams until the samples are transferred or dispatched properly. A person is usually designated to receive the samples from the field samplers after decontamination. This person maintains custody until the samples are dispatched. As few people as possible should handle the samples.

Sample shipments to the analytical laboratory are accompanied by a chain of custody form. The chain of custody form contains the following information:

Project name

Sampler's name

Sample number

Sampling date

Sampling destination

Special handling requirements

Forms will be filled out with waterproof ink. When transferring samples, the individuals involved will sign, date, and note the time on the form.

Samples are packed properly for shipment and dispatched to the laboratory for analysis, with a separate chain of custody record accompanying each shipment. A sample analysis request form, which specifies the analysis requested for each sample and any preservatives used, will also accompany each shipment of samples to the laboratory. Copies of both forms are retained by the sampler.

Once received at the laboratory custody procedures will apply. It is then the laboratory's responsibility to maintain custody records throughout sample preparation and analysis.

SAMPLE SHIPMENT AND DELIVERY

After being properly contained, preserved and documented, samples will be shipped or delivered to the analytical laboratory, according to the sample packing and shipping procedures included in the site specific sampling plan. Samples must be packaged and transported in accordance with Federal and State statutes and regulations, particularly 49 CFR 172.101. The samples will be delivered to the laboratory manager. The analytical laboratory should be contacted before the sampling event so that delivery of the samples can be arranged. If non-hazardous samples are sent by mail, the package is registered and a return receipt is requested. Holding times should be considered when developing sampling and shipping schedules.

Section 5

RESPONSE ACTION DECISIONS

Section 5

RESPONSE ACTION DECISIONS

5.1 Introduction

This section provides guidance on the process to be followed in making response action decisions for both removal and remedial sites. The HEER Office has final decision-making authority regarding what response actions are to be taken at a site. PRPs who are conducting site investigations, and developing and evaluating clean up alternatives, may make recommendations to the HEER Office regarding proposed clean up alternatives. However, the HEER Office must approve all cleanup proposals at sites where the HEER Office has taken an active oversight role at the site. For sites at which the HEER Office is not providing oversight (voluntary cleanups at low and medium priority sites), cleanup decisions made by parties conducting the response should be consistent with the guidance provided in this manual. Technical issues not covered by this manual should be presented to the HEER Office for consideration and evaluation as to their applicability to sites in the State of Hawaii. In general, the HEER Office encourages the use of presumptive remedies wherever possible to streamline the decision-making process. In the absence of an appropriate presumptive remedy for a site, site cleanup decisions will be made on a site by site basis using the results of site specific site characterization and alternative analysis.

5.2 Removal vs. Remedial

Response actions, whether designated as removal or remedial, are actions taken to abate or mitigate a threat to human health or the environment. Removal actions are generally short-term response actions taken to abate or mitigate a threat to human health or the environment. Removal actions differ from remedial actions in a number of significant ways. First, removal actions can be conducted at sites that require a less complex investigation phase to fully characterize the release and select an appropriate response action. Sites at which 1) extensive groundwater contamination exists or 2) complex mixtures of chemicals are present in surface or subsurface soils are generally not addressed through removal actions.

A second area where removal actions differ from remedial actions is in the number and complexity of cleanup alternatives that need to be evaluated prior to selecting a cleanup alternative. Finally, a third area where removal actions differ from remedial actions is the degree of public participation activities required prior to selection and implementation of the response action. The public participation requirements for removal and remedial actions are outlined in this Section and in Section 8.

The HEER Office anticipates that the removal procedures described in this manual will be applicable to the majority of sites entering the system, perhaps in excess of 75% of those sites. In deciding whether to follow the removal or remedial process, the HEER Office will consider the following factors:

1. The immediacy of the threat;
2. Planning time;
3. Implementation time;
4. The degree of risk to public health or welfare or the environment or natural resources;
5. Cost;
6. Community interest;
7. Site complexity;
8. The availability of other appropriate response mechanisms; and
9. Other situations which may pose imminent and substantial threat to human health and the environment.

To the extent practical and given the circumstances present at a site, the HEER Office will utilize the removal process to address the entire release or threat of release present at a site. If it is not possible to address the extent of contamination at a site through a single removal action, more than one removal action may be conducted.

Removal actions may also be conducted at any point in the remedial process if there are opportunities to accelerate cleanup and reduce risks posed by the site consistent with long-term actions.

5.3 Removal Action Process

Removal actions are prompted by the unique circumstances of a release or potential release of hazardous substances. The following removal action descriptions are provided as examples only; many other situations may also be considered removal actions.

- Fences, warning signs, or other security or site control precautions -- where restricted access is required
- Drainage controls (e.g., run-off or run-on diversion) -- where needed to reduce migration of hazardous substances, pollutants, or contaminants off-site or to prevent precipitation or run-off from other sources (e.g., flood waters) from entering the release area from other areas.
- Stabilization of berms, dikes, or impoundments, or drainage or closing of lagoons where needed to maintain the integrity of the containment structures

- Placement of a cap on contaminated soils or sludges -- where needed to reduce exposure and migration of hazardous substances or pollutants or contaminants into the soil, groundwater, surface water or air.
- Excavation, consolidation, or removal of contaminated soils from drainage or other areas -- where removal will reduce the spread of or direct contact with contamination
- Removal of drums, barrels, tanks, or other bulk containers that contain or may contain hazardous ignitable or explosive substances or pollutants or contaminants -- where it will reduce the likelihood of spillage, leakage, and exposure to humans, animals, or the food chain.
- Containment, treatment, disposal, or incineration of hazardous materials -- where needed to reduce the likelihood of human, animal, or exposure to sensitive ecosystems
- Provision of alternative water supply -- where it will reduce the likelihood of exposure to contaminated water.

5.3.1 Review of Existing Information

Information gathered during investigations by federal, state, local agencies, and PRPs, such as the site assessment report, OSC reports, or a site summary report, will be used to evaluate whether a removal action should be conducted, and if so, what the appropriate action should be.

Information reviewed should at a minimum address the following:

1. Identification of the source
2. Magnitude of the threat
3. Whether a removal is appropriate
4. If another party is undertaking the proper response action

5.3.2 Collect Additional Data

If sufficient information does not exist to make a determination of the need for a removal action, a limited amount of data should be collected to make that determination. All data gathered during the investigation of a site should also be collected for future use in any potential remedial action.

5.3.3 Removal Action Development/Evaluation/Selection

The removal action shall to the extent practicable:

1. Address all immediate threats to public health and the environment;
2. Permanently and completely address the threat posed by the entire site; and
3. Contribute to any anticipated or potential remedial action.
4. Presumptive remedies known to address particular contaminants and site conditions will be listed in the manual for use in the determination of appropriate removal/response actions.

5.3.4 Removal Action Report (RAR)

RARs are completed by either the HEER Office or a PRP and will address, at a minimum, the following:

1. The location of the release or threat of release;
2. The cause of the release or threat of release;
3. The initial situation at the facility or vessel which preceded the decision to conduct a removal action;
4. Any efforts conducted by the department to obtain a response by other parties, if appropriate;
5. The removal action and alternatives considered, if any;
6. A removal schedule and quarterly progress reports;
7. The resources expended; and
8. A description of the types and levels of hazardous substances or pollutants or contaminants remaining on-site, if any, through verification sampling.

The RAR will be added to the Administrative Record for the site.

For those instances where it is practicable, as determined by the HEER Office, the RAR will be completed before the initiation of the removal action. If the HEER Office determines that it is not practicable to complete a RAR before the initiation of the removal, the RAR will be completed following the completion of the removal action.

5.4 Remedial Action Process

5.4.1 Scoping and Planning

Scoping is the initial phase of the RI/RAA process, and many of the planning steps begun here are continued and refined in later phases of the RI/RAA. Scoping activities typically begin with the collection of existing data, including data from previous investigations such as the preliminary assessment and site investigation. On the basis

of this information, site management planning is undertaken to preliminarily identify boundaries of the study area identify likely remedial action objectives and whether removal actions may be necessary or appropriate, and to establish whether the site may best be remedied as one or several separate operable units. Once an overall management strategy is agreed upon, the RI/RAA for a specific project or the site as a whole is planned. Typical scoping activities include:

- Initiating the identification and discussion of potential Applicable Requirements (ARs) with the support of other involved agencies
- Determining the types of decisions to be made and identifying the data and other information needed to support those decisions
- Assembling a "technical advisory committee" to assist in these activities, to serve as a review board for important deliverables, and to monitor progress, as appropriate, during the study
- Preparing the work plan, the sampling and analysis plan (SAP) [which consists of the quality assurance project plan (QAPP) and the field sampling plan (FSP)], the health and safety plan, and the community relations plan.

5.4.2 Data Collection

During site characterization, field sampling and laboratory analysis are initiated. Field sampling may be phased so that results of the initial sampling efforts can be used to refine plans developed during scoping to better focus subsequent sampling efforts. Data quality objectives are revised as appropriate based on an improved understanding of the site to facilitate a more efficient and accurate characterization of the site and, therefore, achieve reductions in time and cost.

A preliminary site characterization may be prepared to provide information on the site early in the process before preparation of the RI report. The site characterization summary will be useful in determining the feasibility of potential technologies and in assisting all involved parties with the initial identification of ARs.

5.4.3 Remedial Investigation Report

A draft RI Report should be produced to serve as documentation of data collection and analysis in support of the Remedial Alternatives Analysis (RAA). The draft RI Report should not delay

the initiation or execution of the RAA Report, and in many instances may be completed as one document. (The CERCLA equivalent of a RAA Report is a Feasibility Study.)

The report should focus on the media of concern and, therefore, does not need to address all the site characteristics, only those appropriate at that specific site. Suggested format for the RI Report is included as a Appendix to this section.

The Report should contain information on the site background, including a site description, the site history, and a summary of previous investigations. The study area investigation should include information on the following:

1. Surface Features
2. Contaminant Source Investigations
3. Meteorological Investigations
4. Surface Water and Sediment Investigations
5. Geological Investigations
6. Soil and Vadose Zone Investigations
7. Groundwater Investigations
8. Human Population Surveys
9. Ecological Investigations

The RI Report should provide an analysis as to the nature and extent of contamination from and sources such as lagoons, sludges, tanks, etc. Also and evaluation of the soils and vadose zone, groundwater, surface water and sediments, and air should be included as appropriate.

The contaminants fate and transport should include discussion of the routes of migration, contaminant persistence, and contaminant migration. A Risk Evaluation of the appropriate Tier Level (I, II, or III) should be contained in the RI.

The RAA Report should include information on the identification and screening of alternative technologies, a discussion of the remedial action objectives, and a detailed analysis of the alternatives selected for consideration.

5.4.4 Remedial Action Development/Selection

The primary objective of this phase is to develop an appropriate range of waste management options that will be analyzed more fully in the detailed analysis phase of the FS Report. Appropriate waste management options that ensure the protection of human health and the environment may involve, depending on site specific circumstances, the complete elimination or destruction of hazardous substances at the site, the reduction of concentrations of hazardous substances to acceptable health based levels, and prevention of exposure to hazardous substances via engineering or institutional controls, or some combination of the above. Alternatives are typically developed concurrently with the RI Site Characterization, with the results of one influencing the other in an iterative fashion.

5.4.5 Remedial Alternatives Analysis Report

The Remedial Alternatives Analysis (RAA) Report should contain the following information:

- a Screening of Alternatives and Threshold Criteria Summary Sheet of alternatives evaluated against the Threshold Criteria according to Section 5.10.2 (i.e., Overall Protection of Human Health and the Environment, and compliance with Applicable Requirements),
- an Assessment of Individual Alternatives and Evaluation Criteria Summary Sheet for assessment of individual alternatives against the three evaluation criteria according to Section 5.10.3 (i.e., effectiveness, implementability, and cost),
- a narrative explanation of the Assessment of Individual Alternatives and Evaluation Summary Sheet,
- a Comparative Analysis of Alternatives and Evaluation Summary Sheet for comparing remedial alternatives according to Section 5.10.3,
- a narrative explanation of the comparative analysis of alternatives and evaluation criteria summary sheet,
- a Final Response Action Memorandum according to Section 6.

A summary of the Remedial Alternatives Analysis Report should be part of the Response Action Memorandum.

5.4.6 Response Action Memorandum

A draft Response Action Memorandum should present the remedial alternative recommended for the site and clear rationale for the recommendation. After public involvement requirements have been satisfied, a final Response Action Memorandum will be available.

Figure 5-1 shows a flow chart of reports which may be generated in documenting site activities.

5.5 Guiding Principals

Throughout the remedial response process, the HEER Office is required to make many complex decisions which contribute to the final decisions made in the RAM to

determine the technology(ies) to be used to remediate the contamination. Built into this process is the requirement for the HEER Office to follow Guiding Principals.

In determining the need for and in planning or undertaking a response action, the HEER Office will to the extent practical adhere to the Guiding Principals set out in Section 11-451-8c. They are as follows:

1. Engage in prompt response actions;
2. Consider, or require to be considered the following hierarchy of response action alternatives in order of descending preference;
 - (A) Reuse or recycling;
 - (B) Destruction or detoxification;
 - (C) Separation, concentration, or volume reduction, followed by reuse, recycling, destruction or detoxification of the residual hazardous substance or pollutant contaminant;
 - (D) Immobilization of hazardous substances or pollutants or contaminants;
 - (E) On-site or off-site disposal, isolation, or containment at an engineered facility designed to minimize the future release of hazardous substances, pollutants or contaminants and in accordance with applicable requirements; and
 - (F) Institutional controls or long term monitoring.

5.6 Identification of Applicable Requirements and Criteria To Be Considered

State regulations require all response actions, including assessment and investigation activities, at a minimum to comply with "applicable requirements." In addition to complying with applicable requirements, the State may as appropriate, identify other advisories, criteria or guidance "to be considered" for a particular release.

Applicable requirements (ARs) are those federal, State and local requirements that are legally applicable to a hazardous substance, pollutant or contaminant, response action, location, or other circumstance found at a facility or vessel or site. However, no state or county permit shall be required for the portion of any removal or remedial action conducted entirely on site where the response action is carried out in compliance with

Chapter 128D, HRS.

To be considered (TBC) elements consist of advisories, criteria, or guidance developed by the federal, State, or local environmental and public health agencies that may be useful in developing response actions. These elements are not legally enforceable but contain information that would be helpful in carrying out or in determining the level of protectiveness of selected remedies. TBCs may be useful in determining health based levels for a particular contaminant or the appropriate method for conducting an action where no ARs exist. In other words, TBCs are meant to complement the use of ARs and not compete with or replace them. Because they are not enforceable like ARs, their identification and use is not mandatory.

The State agency or the potentially responsible party (PRP) which is undertaking the response action should begin identifying ARs as the clean up goals early in the site investigation stage. ARs will also be looked at later in the alternatives development phase after the initial screening, but prior to the detailed analysis of the alternatives. TBC elements will also be looked at in the same timeframe.

5.6.1 Types of Applicable Requirements

Any of the many federal, State and local environmental requirements has the potential to be an AR. Due to the complexity of the universe of such requirements, ARs have been divided into three categories to help in their identification.

Chemical-Specific Requirements

Chemical-specific ARs are usually health or risk-based numerical values or methodologies which when applied to site-specific conditions result in the establishment of the acceptable amount or concentration of a chemical that may remain in or be discharged into the environment. If a chemical has more than one such requirement that is determined to be an AR, the most stringent generally should be complied with. At present, there are only a limited number of chemical-specific requirements.

Location-Specific Requirements

A site's location is a fundamental determinant of its impact on human health and the environment. Location-specific ARs are restrictions placed on the concentration of the hazardous substances or the conduct of activities solely because they are in specific locations.

Requirements addressing wetlands, historic places, floodplains or sensitive ecosystems and habitats are potential location-specific ARs. An example of this

requirement is the Clean Water Act 404 prohibitions of the unrestricted discharge of dredged or fill material into wetlands.

Action-Specific Requirements

Action-specific ARs are usually technology or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to implement a remedy. Since there are usually several alternative actions for any remedial site, very different requirements can come into play. These action-specific requirements do not in themselves determine the remedial alternative, but rather indicate how a selected alternative must be implemented. Requirements that dictate the design, construction and operating characteristics of incinerators, air stripping units or a landfill construction are examples of action-specific ARs.

5.6.2 Scope of Applicable Requirements

ARs are identified on a site-by-site basis for all on-site response actions where Chapter 128D HRS authority is the basis for the cleanup. Cleanups at state sites, regardless of which party has the lead must comply with ARs.

All response actions taken under Chapter 128D must meet ARs at the completion of the action. HRS provides for the on-site work to comply with only the substantive, but not the administrative portion of any permit requirements. Complying with ARs both during the implementation and upon completion of an action helps the lead party define the ways in which the activity can be carried out in a manner that is protective of human health and the environment.

5.6.3 On-Site vs. Off-Site

It is important to note that in Chapter 128D-23, the exemption from state and county permits applies to response action conducted entirely "on-site". The HEER Office intends to apply the same standard as the federal Superfund rules. According to the federal Superfund rules (National Oil and Hazardous Substances Pollution Contingency Plan or NCP), the term "on-site" means the geographical (or areal) extent of the contamination and all suitable areas in very close proximity to the contamination that are necessary for implementation of the response action. This definition includes the surface area of the site and the air above the site, as well as the subsurface contamination, including the groundwater plume. Cleanup actions that fall within this definition must meet the substantive but not the administrative requirements of state and county permits. On the other hand, response actions carried out off-site are subject to applicable law, including all administrative requirements related to state and county permits.

5.6.4 List of Potential ARs (Federal and State) and TBCs

Table 5-1 is a list of the Potential ARs. However, these decisions must be made on a site by site basis. Additional detail on these ARs and TBCs is included as a Appendix to this Section.

Table 5-1
List of Potentially Applicable Requirements

| Applicable Requirement | Citation |
|--|---|
| HI Water Quality Standards | HAR Title 11, Chapter 54 |
| HI Water Pollution Control Regulations (NPDES) | HAR Title 11, Chapter 55 |
| HI Solid Waste Pollution Act | HRS Title 19, Chapter 342H |
| HI Solid Waste Management Control Standards | HAR Title 11, Chapter 58 |
| HI Water Systems Regulations | HAR Title 11, Chapter 62 |
| HI Emergency Plan for Safe Drinking Water | HAR Title 11, Chapter 19 |
| HI Potable Water Systems Regulations | HAR Title 11, Chapter 20 |
| HI Cross-Connection and Backflow Control Ordinance | HAR Title 11, Chapter 21 |
| HI Underground Injection Control Standards | HAR Title 11, Chapter 23 |
| HI Used Oil Act | HRS Title 19, Chapter 342N |
| HI Underground Storage Tanks Act | HRS Title 19, Chapter 342L |
| HI Ambient Air Quality Standards | HAR Title 11, Chapter 59 |
| HI Air Pollution Control Rules | HAR Title 11, Chapter 60 |
| HI Sanitation Regulations | HAR Title 11, Chapter 11 |
| HI Occupational Safety and Health Standard | HAR Title 12, Chapter 99 |
| HI Endangered and Threatened Species Regulations | HAR Title 13, Part II, Chapters 122 and 124 |
| HI Conservation Regulations | HAR Title 13, Part II, Chapter 124 |

5.7 Use of the Aquifer Classification System (ACS)

Soil and groundwater clean up criteria for remedial activities are based in part on the utility of the groundwater impacted or potentially impacted by the release. Clean up criteria for releases that threaten sources of drinking water are based on primarily on human health concerns. Clean up criteria for releases that threaten non-drinking water sources are primarily based on ecological/aquatic-life concerns.

The HEER Office will incorporate the Water Resources Research Center (WRRC) at the University of Hawaii "Aquifer Identification and Classification" technical series into existing guidelines for approximation of groundwater utility at hazardous waste sites.

The Aquifer Identification and Classification System (ACS) reports systematically review aquifer systems throughout each island and, as one element, indicate whether the aquifer system as a whole can or cannot be utilized as a source of drinking water (aquifer system "utility" is the second digit in aquifer system status code).

While the HEER Office recommends the use of the ACS to approximate the groundwater utility at a site of a release, we reserve the right to request additional site specific geologic, hydrogeologic, and other pertinent information as necessary on a site by site basis to make final groundwater utility determinations. In particular, facilities located near aquifer system boundaries should evaluate the geological accuracy and applicability of the ACS maps to their site.

Additionally, sites in ecologically sensitive areas must consider this ecological risks from the site when making a clean up criteria decisions.

5.8 Tiered Risk Assessment Approach

DOH recognizes that contaminated sites vary greatly in the type and quantity of contamination and the risk they present to human health and the environment. This guidance provides an approach for streamlining the evaluation and cleanup of contaminated sites by tailoring response actions to site-specific conditions and risks. The framework outlined in this chapter is consistent with guidance published in the American Society for Testing and Material "Emergency Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites" (1994), the U.S. EPA's "Draft Guidance for Soil Screening Level Framework (1994), and EPA Region IX Preliminary Remediation Goals (1995). For further detail please consult these references.

As described in EPA's Draft Guidance for Soil Screening Level Framework and Region IX Preliminary Remediation Goals (PRGs), preliminary Tier 1 action levels (PALs) for soil and groundwater represent a level of contamination below which there is no

concern provided that the exposure pathways and exposure scenarios at the site are fully accounted for. PALs are useful in determining whether additional investigation is warranted and provide an initial cleanup goal if applicable. Exceeding the PAL does not necessarily mean that the site is contaminated or triggers a response action.

DOH is using a tiered approach to site investigation, risk assessment and remedial action selection. Higher level tiers involve more detailed site characterization and data requirements. The conservative assumptions of lower tiers are replaced with site-specific assumptions. Decisions to move to higher tiers should be based on a cost/benefit analysis, considering the probability that Tier 2 cleanup goals will be less costly to attain than Tier 1 PALs.

Additional detail on the development of this approach can be found in the HDOH Guidance Document entitled, "Risk Based Corrective Action and Decision Making at Sites with Contaminated Soil and Groundwater. (12/95)" Volume 1 of this policy is included as an Appendix to this Section. Default levels can be found in this policy. HDOH encourages the use of the spreadsheet developed by the UST Program to facilitate quick review of Tier 2 derived action levels.

The framework presents a three-tiered approach to the evaluation of contaminated sites. The options discussed in this guidance range from generic PALs (Tier 1) which have been derived by DOH to full-scale risk assessment (Tier 3) requiring extensive site characterization data along with complex fate and transport modeling. Detailed information for a Tier 3 evaluation is also included as an Appendix to this Section. The tiered approach is discussed in more detail in the appendices.

5.8.1 Numerical Limits for TPH in Soil

In addition to risk-based PALs, upper limits for total petroleum hydrocarbon (TPH) in soil have been designated to address offset migration, future development and aesthetic concerns. When toxic constituents such as BTEX, PAHs, and or Lead are not encountered at levels which potentially pose a threat to public health or the environment, and TPH is encounter at levels greater than 2 feet below the ground surface, then the following action levels are not to be exceeded:

1. TPH - oil and diesel 5,000 mg/kg
2. TPH - gasoline 2,000 mg/kg

Because of its non-specific nature, Hawaii does not use TPH as a risk-based PAL. Rather, PALs have been developed for some of the most toxic and mobile constituents in gasoline, middle distillates and heavier distillate products.

Additional information on sites which TPH is the primary contaminant of concern can be found in Section 9.

5.8.2 Ecological Assessments

Section 4.5.5 of this TGM discusses ecological concerns related to risk determination. For simplicity sake, all of this guidance is maintained in one section of this TGM. If ecological concerns are a factor at the site, then these issues must be addressed in conjunction with the human health receptors.

5.9 Use of Groundwater Models

The HEER Office's policy on the use of models is that an appropriate model should only be used as a tool to assist clean up decision making and shall not be relied upon in lieu of actual data gathering conventionally used for site characterization. Models should not be routinely used at all hazardous waste sites -- only when the results from the model will provide valuable information to aid the decision-making process.

However, the HEER Office recognizes the value of modeling, in conjunction with sufficient environmental measurements made during site characterization, for certain areas where full characterization of groundwater may not be necessary or appropriate. The use of any model should be coupled with model calibration and field verification. The HEER Office will determine the appropriateness of model use on a case by case basis.

The degree to which the HEER Office will allow the use of models will be determined by the ability of modeling efforts to complement geochemical and/or physical site specific data. This determination will in part be based upon the nature and extent of contamination, soil types, depth to groundwater, future land use, future groundwater use, environmental sensitivity of the site, and the toxicity of the contaminants. If site characterization is estimated by conducting limited sampling and modeling the fate and transport of the contamination, then, models should be confirmed and amended through out the site characterization process.

The use of literature values for modeling shall be minimized. During the early stages of site characterization, the necessary principal physical parameters should be planned for and then incorporated into the sampling and analysis plan. When site conditions or other constraints are not favorable for field sampling or analysis, conservative (worst case) values of the particular model parameter must be utilized. Modeling efforts should also take into account the principal soil series found at the contaminated site.

When the use of models is employed, the modeling conclusions shall at least include a table with individual model parameters, assumptions data sources, and other relevant

comments such as methods of determination. The results shall also contain sample calculations for any calculated values, soil boring logs (if conducted), and a summary of any field sampling and field test measurements, pursuant to the sampling and analysis plan.

5.10 Alternatives Evaluation

In the remedial action development phase, preliminary remediation goals first developed during the Remedial Investigation are further developed and refined into specific remedial action alternatives. The alternatives may range from addressing the most highly contaminated waste through treatment, to utilizing engineering controls (e.g. containment) supplemented by institutional controls for low-level contaminants and wastes for which treatment is impracticable. To the extent practicable, presumptive remedial actions should be identified, evaluated, and selected where the contamination present can be treated, contained or disposed of in a manner which has proven successful at similar sites with similar contamination. The selection of presumptive remedial actions may be based on analyses conducted for other similar sites with similar contamination using a minimum of data collection and analysis for the site under consideration.

5.10.1 Purpose and Goal

The purpose of the remedial action development and selection process is to develop alternatives that protect public health, welfare or the environment by eliminating, reducing or controlling risks posed by a site. The goal is to develop and select remedial actions that provide for efficient, cost effective and long-term reliable solutions which are protective of public health, welfare and the environment.

5.10.2 Establishing Alternatives

Establish Remedial Action Objectives

Once a conceptual understanding of the site is obtained, remedial action objectives should be developed for each media to be addressed. These remedial action objectives consist of medium or operable-unit specific goals for protecting human health and the environment. The objectives should specify the contaminants and media of concern, the exposure routes and receptors, and the remediation goals for each exposure route.

The development of the remedial action objectives for protecting human health and the environment are established by considering readily available information such as applicable requirements (ARs). For systemic toxicants, acceptable cleanup levels shall be at levels which will not adversely affect the human population by incorporating an

adequate margin of safety. For known or suspected carcinogens, acceptable cleanup levels should be based on a cancer risk of 10^{-4} to 10^{-6} . The findings of natural resource assessments which address adverse impacts to ecological receptors will be used to establish cleanup levels for contaminants which may cause ecological impacts.

Develop General Response Actions

General response actions are selected to satisfy the remedial action objectives for each medium of concern. These response actions, initially defined during scoping, are refined during this phase and relate to the basic methods of protection such as treatment, containment or disposal. General response actions may be combined to form alternatives, for example, the treatment of highly toxic material with containment of the treatment residuals.

A determination should be made of the volume or area of contaminated media to which the general response actions might be applied. This determination should be based on the exposure routes, the nature and extent of the contamination, preliminary remediation goals and any action-specific ARs. Action-specific ARs set restrictions on particular remedial activities as related to the management of hazardous wastes.

For source control actions, the HEER Office requires that one or more alternatives be developed utilizing treatment of waste to reduce the toxicity, mobility or volume of the hazardous substances or contaminants. The HEER Office also requires one or more alternatives that involve little or no treatment but provide protection of public health through engineering controls, such as containment, and as necessary institutional controls.

For ground-water remedial actions, the HEER Office requires the development of a limited number of remedial alternatives that attain site-specific remediation levels within different restoration time periods utilizing one or more different technologies.

Identify and Screen Appropriate Technologies

With the selection of the general response actions completed, the next step is to identify the type of technologies available for the response actions. A list of potentially applicable technologies and technology process options corresponding to the identified general response actions should be compiled and then reduced by evaluating the process options with respect to their technical implementability. Existing information on technologies and site characterization data are used to screen out process options that cannot be effectively implemented at the site.

The selected list should then be screened to eliminate all those options which do not meet the Threshold Criteria. The Threshold Criteria are: 1) compliance with ARs, and

2) overall protection of public health and the environment. Any technology which does not meet both of these criteria, should be eliminated from further consideration.

Select Representative Process Options

To simplify the development and evaluation of alternatives, one representative process option should be selected, if possible, for each technology type remaining after the screening procedure. Effectiveness, implementability and cost are the criteria used to evaluate and select the representative process options.

Assemble Technologies into Alternatives

To assemble alternatives, general response actions should be combined using different process options applicable to different volumes of media or areas of the site to meet all remedial action objectives. For example, an alternative may call for incinerating the most highly contaminated soil from a portion of the site, while capping other less contaminated areas.

The alternative development process should focus only on the most viable options for site remediation. If a large number of viable alternatives remains at the conclusion of the assembly of alternatives, an additional screening process should be used to limit the number of alternatives that must undergo a detailed analysis. Generally, no more than five source control alternatives should be carried through to the detailed analysis. Additionally, a no-action alternative and at least one permanent remedy alternative should be maintained throughout the analysis. Fewer alternatives may be appropriate in the case of an early action where options are limited or when program guidance or ARs establish appropriate alternatives.

5.10.3 Analysis of Remedial Action Alternatives

Individual Analysis of Alternatives

Once the remedial action alternatives are sufficiently defined to allow for further evaluation, each alternative is assessed against three evaluation criteria: effectiveness, implementability and cost. (Note: At this point in the analysis, it is assumed that all of the alternatives that have been carried through to this point satisfy two overall requirements of 1) complying with applicable requirements and 2) being protective of human health and the environment. If an alternative does not meet these minimum requirements, it should be eliminated from further consideration.)

These three criteria (effectiveness, implementability, and cost) have been designed to enable the analysis of each alternative to address the regulatory requirements of the State Contingency Plan, and the technical and policy considerations important for

selecting among remedial alternatives. These evaluation criteria, listed in Table 5.2, provide the framework for conducting the analysis and selecting the appropriate remedial action. The individual analysis of alternatives should evaluate the performance of each alternative against the evaluation criteria, highlighting the specific strengths and weaknesses of each. Section 5.10.4 provides additional detail on the criterion for evaluation.

Effectiveness

The effectiveness criterion focuses on the degree to which an alternative reduces toxicity, mobility and volume through treatment; minimizes residual risks and affords long-term, reliable protection; complies with applicable requirements; minimizes short-term impacts and how quickly it achieves protection. Alternatives providing significantly less effectiveness than other more promising alternatives may be eliminated.

Implementability

The implementability criterion focuses on the technical feasibility of each alternative; the availability of technology for each alternative under consideration; and the administrative feasibility of implementing the alternative. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time, may be eliminated from further consideration. The implementability criterion also includes the level of community acceptance of the remedial action.

Cost

The cost criterion considers the cost of construction and any long-term costs to operate and maintain the equipment. Costs that are grossly excessive compared to the overall effectiveness of other alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at a greater cost, may be eliminated.

Comparative Analysis

Once the alternatives have been fully described and individually assessed against the three criteria, a comparative analysis should be conducted to evaluate the relative performance of the alternatives in relation to each criterion. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that the tradeoffs that will have to be balanced to select a remedy will be well understood.

5.10.4 Detailed Analysis of Alternatives

This section provides additional detail for performing a detailed analysis of remedial action alternatives and supplements Section 5.10.3. The extent to which alternatives are analyzed during the detail analysis is influenced by the available data, the number and types of alternatives being analyzed, and the degree to which alternatives were previously analyzed during their development and screening.

Effectiveness

The effectiveness of an alternative refers to its ability to meet the objective within the scope of the remedial action. The following are the factors to be considered under this criterion.

Overall Protection of Human Health and the Environment

How well each alternative protects public health and the environment shall be discussed in a consistent manner. This discussion draws on assessments conducted under other evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with applicable requirements.

The process for determining if an alternative is protective of human health and the environment is given in Section 6.3, Threshold Criteria for Alternatives.

Compliance with Applicable Requirements

The detailed analysis should summarize which requirements are applicable to an alternative and describe how the alternative meets those requirements. (See Table 5.1 and the Appendix, for a list of applicable requirements).

Minimize Residual Risks and Affords Long-term Reliable Protection

This evaluation addresses the results of a remedial action in terms of its permanence and quantity/nature of waste or residual remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes at the site.

Reduction of Toxicity, Mobility, or Volume Through Treatment

This evaluation criteria assesses the remedial alternative's use for treatment technologies that permanently and significantly reduce toxicity, mobility or volume of the hazardous wastes as their principal element. This evaluation will be based upon

several factors such as:

- amount of hazardous materials to be destroyed or treated;
- degree of reduction expected in toxicity, mobility, or volume;
- type of quantity of residuals that will remain after treatment;
- degree to which the treatment will be irreversible.

Short-Term Effectiveness

The short term effectiveness criterion addresses the effects of the alternative during implementation before the removal objectives have been met. Alternatives should be evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The following factors should be addressed as appropriate for each alternative:

- protection of community,
- protection of workers,
- environmental impacts,
- time until response objectives are achieved.

Implementability

This criterion, implementability, addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration. The implementability criterion involves analysis of the following factors:

Technical Feasibility

This factor deals with (1) the ability to construct and operate the technology, (2) the reliability of the technology, and (3) the ability to monitor the effectiveness of the remedy.

Administrative Feasibility

The administrative feasibility factor evaluates those activities needed to coordinate with other offices and agencies. The administrative feasibility of each alternative should be evaluated, including the need for off-site permits, adherence to applicable non-environmental laws, and concerns of other regulatory agencies.

Availability of Services and Materials

This factor focuses on the availability of the following services and materials for the selected remedy:

- personnel and equipment;
- adequate off-site treatment, storage, and disposal;
- services and materials;
- Prospective technologies.

Community Acceptance

Community acceptance of the alternative will be considered in making the final selection of the remedy.

Cost

This criterion consists of determining the projected costs of each remedial alternative. Costs that are grossly excessive compared to the overall effectiveness of other alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated.

Direct Capital Costs

Direct capital costs may consist of construction costs, equipment and material costs, land and site acquisition costs, building and services costs, analytical costs, contingency allowances and treatment and operating costs.

Indirect Capital Costs

Indirect Capital Costs may include engineering and design expenses, legal fees and license or permit costs and start-up and shakedown costs.

Annual Operation, Maintenance and Monitoring Costs

Annual costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action. The following annual costs components should be considered:

- operating labor costs,
- maintenance materials and labor costs,
- auxiliary materials and energy.

Accuracy of Cost Estimates

Site characterization and treatability investigation information should permit the user to refine cost estimates for remedial action alternatives. It is important to consider the accuracy of costs developed for alternatives in the remedial alternatives analysis (RAA). Typically, these "study estimate" costs made during the RAA are expected to provide an accuracy of 50 percent to -30 percent and are prepared using data available from the remedial investigation. Costs developed with expected accuracies other than +50 percent to -30 percent should be identified as such in the RAA.

Assessment of Individual Alternatives Against Evaluation Criteria

The analysis of individual alternatives against the three evaluation criteria should be presented in the draft response action memorandum (RAM) as a narrative discussion accompanied by a summary table. This information will be used to compare the alternatives and support a subsequent analysis of the alternatives made by the decision-maker in the remedy selection process. The narrative discussion should, for each alternative, provide (1) a description of the alternative and (2) a discussion of the individual criteria assessment.

The long-term effectiveness provided by each alternative should be specifically described and an estimate of the effective life of the remedy, in years, should be developed. This is important to provide a complete description of the relative benefit of alternatives and make possible an accurate assessment of the overall benefits of distinct alternatives as described in Section 5.10.3, Comparative Analysis of Alternatives and Evaluation Criteria.

At least one permanent remedy should be developed for each site to force the decision maker to describe what is required to achieve permanence, and, if this alternative is not selected, to give reasons why permanence will not be achieved. It also provides a baseline against which to compare what other remedial alternatives will achieve. A no-

action alternative should also be considered to provide a base line for the analysis.

At least one detailed alternative that reduces the toxicity, mobility, or volume of the contaminant(s) by treatment should be developed for each site. Treatment is usually, the best means of achieving long-term effectiveness. All potentially effective technologies and combinations of technologies should be explored to provide a full range of options for the site. It is important that treatability studies be performed if insufficient information is available as to the suitability of a particular technology. This testing is important so that alternatives can focus on the specific long-term benefits that treatment provides.

Comparative Analysis of Alternatives and Evaluation Criteria

Once the alternatives have been fully described and individually assessed against the above criteria, a comparative analysis should be conducted to evaluate the relative performance of the alternatives in relation to each specific evaluation criterion. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so the tradeoffs that will have to be balanced to select a remedy are fully understood.

The comparative analysis of alternatives may be simplified by comparing total cost to the single criterion of long-term effectiveness to provide a relative evaluation of the overall value of each alternative. Since all alternatives will be developed to protect human health and the environment, evaluating long-term effectiveness considers how each alternative protects human health and the environment over time while also considering the preference for permanence and reducing the toxicity, mobility, or volume of the contaminant(s) by treatment. The cost estimate for each alternative should incorporate the costs of controlling short-term risks and the costs of implementation. Thus, comparing costs to long-term effectiveness implicitly evaluates both of the other evaluating criteria.

The alternative which achieves the site cleanup objectives at the lowest cost should be identified. Since all alternatives that meet objectives will protect human health and the environment, then this alternative represents the "floor" for the cost-effectiveness evaluation. In like manner, the cost of achieving a permanent remedy sets the "ceiling". If there are two or more permanent remedies, the lowest cost permanent remedy should be used.

The floor and ceiling act as guidelines to evaluate all of the alternatives. Between the floor and ceiling, all other alternatives should be ranked according to the degree of long-term effectiveness provided by each, with the permanent remedy ranked number one. Comparing this ranking with the total present value cost of each alternative provides the decision maker a sense of the relative value of each alternative with

regard to long-term effectiveness. Some alternatives will clearly drop out of the evaluation. The remaining alternatives will provide a range of costs and outcomes. Since all the alternatives under consideration must achieve site objectives and will therefore be protective, the challenge will be to select the alternative that also provides the greatest long-term effectiveness for the lowest cost.

Community concerns should also be expressly considered in selecting among alternatives. Although it is not possible to quantify community concerns to include these concerns in evaluating costs, these issues will often be the deciding factor between alternatives providing similar levels of long-term value. In applying this remedy selection approach, the preferences of the community should be incorporated into the objective-setting and alternative development steps so that some basis of support exists for each of the alternatives available.

TABLE 5.2
Objectives/Criteria To Be Used in
Comparative Analysis of Alternatives

- ☐ Effectiveness
- ☐ Protectiveness
 - ☐ Protective of public health and community
 - ☐ Protective of workers during implementation
 - ☐ Protective of the environment
 - ☐ Complies with ARs
- ☐ Ability to Achieve Remedial Action Objectives
 - ☐ Level of treatment/containment expected
 - ☐ No residual effect concerns
- ☐ Implementability
- ☐ Technical Feasibility
 - ☐ Construction and operational considerations
 - ☐ Demonstrated performance/useful life
 - ☐ Adaptable to environmental conditions
- ☐ Availability
 - ☐ Equipment
 - ☐ Personnel and services
 - ☐ Outside laboratory testing capacity
 - ☐ Off-site treatment and disposal capacity
- ☐ Administrative Feasibility
 - ☐ Permits required
 - ☐ Easements or right-of-ways required
 - ☐ Impact on adjoining property
 - ☐ Ability to impose institutional controls
- ☐ Cost
 - ☐ Capital cost
 - ☐ Operation and maintenance costs
 - ☐ Present worth cost

5.11 Technology Options

5.11.1 Presumptive Remedies

The experience at hazardous waste sites nationally has demonstrated that certain categories of sites have similar characteristics, such as types of contaminants present, types of disposal practices, and the environmental media affected. Based on the information acquired from evaluating and cleaning up these sites, the HEER Office encourages the use of "presumptive remedies" that are appropriate for certain categories of sites. The goal for the use of presumptive remedies is to streamline site investigations and selection of clean up actions at various site categories. When a presumptive remedy is used, the RAA should only compare the presumptive remedy and the no action alternative. This will result in consistency in remedy selection and reduce the costs and time required to clean up similar sites.

Table 5.3
Presumptive Remedies

| Site Type/Common Issue | Potential Presumptive Remedy |
|---|--|
| Solvent (VOC) Contamination | Soil Vapor Extraction Thermal Desorption Incineration |
| Wood Treaters | For Organics Incineration Bioremediation Dechlorination For Inorganics Immobilization |
| Municipal Landfills | Containment capping, leachate collection & treatment, and gas treatment |
| Petroleum Contaminated Soil | Soil Vapor Extraction Bioventing Capping |
| Groundwater VOC/Petroleum Contamination | Pump & Treat with Aqueous Phase Carbon Pump & Treat with Air Stripping |

5.11.2 Treatability Studies

Treatability studies are used to evaluate the effectiveness, implementability, and/or cost of a given technology. The information obtained from the study may be used to select the best technology from among several remedial alternatives. In addition, after a technology has been selected, treatability testing may be used to provide the detailed design, cost, and performance data needed to optimize the treatment processes and to implement full-scale treatment systems. Treatability studies may be expensive and/or time consuming. Therefore, the economics of cost and time should be taken into consideration when planning treatability studies.

There are three kinds of treatability studies: bench, pilot and full-scale testing. None or all of these studies may be needed on a case-by-case basis. Technologies generally are evaluated first at the bench-scale level. The technology may then progress through the pilot-scale to a full-scale field test. However, a technology may enter at whatever level is appropriate based on available data (e.g., literature search and expert consultation) and site-specific factors.

The choice of bench-scale testing versus pilot-scale testing is affected by the level of development of the technology. For a technology that is well developed and tested, bench-scale studies are often sufficient to evaluate performance on new wastes. For innovative technologies, however, pilot-scale tests may be required since information necessary to conduct full-scale tests is either limited or nonexistent. Pilot-scale studies are usually not required for well-developed technologies except when treating a new waste type or matrix that could affect the physical operating characteristics of a treatment unit.

Treatability studies should be planned and implemented as soon as the general extent of contamination is known and it is evident that insufficient information is available to support the decision necessary for remedy selection or remedy implementation.

Treatability study goals should be specified before the test is conducted. They may be based on cleanup criteria developed in Section 5.8, Tiered Risk Assessment Approach. The goals may also be based on the data needed to perform the Detailed Analysis of Remedial Action Alternatives in Section 5.10.3 and 5.10.4 (e.g., data needed to determine implementability, cost and permanence). The goals may consider the following factors:

- Clean up levels that are protective of human health and the environment (e.g., contact, ingestion, leaching) if treated waste is left unmanaged or is managed;
- Clean up levels that are in compliance with AR's;

- Clean up levels that ensure a reduction of toxicity, mobility, or volume;
- Clean up levels acceptable for delisting of the waste; and
- Clean up levels set for another site with contaminated media with similar characteristics and contaminants.

Interpretation of treatability study data should be based on the test objectives established prior to testing. The investigating party is responsible for interpreting the treatability study data and for preparing a treatability study report.

Reporting the Treatability Study Results

The results of treatability studies should be reported to the HEER Office in a treatability study report. The introductory section of the treatability study report should contain background information about the site, waste stream, and treatment technology. This section should also include a summary of any treatability studies previously conducted at the site.

The conclusions and recommendations section should present the conclusions and recommendations regarding the applicability of the treatment process tested. The following questions should be answered:

- Were the performance goals met? Were the other test objectives achieved? If not, why not?
- Were there any problems with the treatability study design or procedures?
- What parts of the test (if any) should have been performed differently? Why?
- Are additional treatability tests required for further evaluation of the technology? Why or why not?
- Are data sufficient for adequately assessing the technology against the threshold criteria (Section 5.10.2) and evaluation criteria (Section 5.10.3 and 5.10.4)? Why or why not?
- Are data sufficient for designing and implementing the remedy (if post-RAM)?

The conclusions and recommendations should be stated briefly and succinctly. Information that is pertinent to the discussion and exists elsewhere in the report should be referenced rather than restated in this section.

This section should provide an analysis of the results as they relate to the objectives of

the study and the relevant evaluation criteria. When appropriate, the results should be extrapolated to full-scale operation to indicate areas of uncertainty in the analysis and the extent of this uncertainty.

The treatability approach section should report why and how the treatability study was conducted. It should describe in detail the procedures and methods that were used to sample and analyze the waste stream and should document any deviation from the Work Plan.

The results and discussion section should include a presentation and discussion of results (including QA/QC). Results for the contaminants of concern should be reported in terms of the concentration in the input and output streams and the percentage reduction in toxicity, mobility, or volume that was achieved. The use of charts and graphs may aid in the presentation of these results. This section also includes the costs and time required to conduct the study and any key contacts for future reference. The appendices should summarize the data generated and the standard operating procedures used.

5.11.3 Innovative Technologies

When alternatives for site remedial actions are being considered, the potential use of innovative technologies may be evaluated. Innovative treatment technologies are alternative remediation techniques based on physical, chemical, and biological treatments of contaminated sites. These technologies may be employed by themselves, or used with traditional or other innovative treatment technologies as treatment "trains."

To comprehend what innovative technologies are, it may be helpful to understand some of the terminology that has been used in the past. Although no official definitions exist, according to EPA documentation, the generally accepted working definitions for the different stages of development status for alternative treatment technologies are as follows:

- Available (existing or established) technology is a technology, such as rotary kiln incineration and conventional solidification/stabilization, that is fully proven in routine commercial use and for which sufficient performance and cost information are available.
- Innovative technology is a treatment technology for which cost or performance information is incomplete, this hindering routine use at hazardous waste sites. An innovative technology may require additional full-scale field testing before it is considered proven and ready for commercialization and routine use.

- Emerging technology is a technology that requires additional laboratory or pilot-scale testing to document the technical viability of the process.

The HEER Office supports the evaluation of innovative technologies for site remediation when conventional technologies are ineffective and/or costly.

5.11.4 Technologies Lists & Matrices

Table 5.4 lists remediation technologies and are for general reference only. They should not be considered as all inclusive or be used as the sole basis for remedy selection.

There are many sources for location of remediation technologies, for example, US EPA, US DOD, and various vendors and environmental contractors. The HEER Office does not endorse the use of any specific source(s), but may provide insight on the application of these technologies in the State of Hawaii.

Table 5.4
Treatment, Containment, Separation and Support Technologies

TREATMENT TECHNOLOGIES

In-situ

- Bioremediation
- Vitrification
- Permeable Barriers

Ex-situ

- Incineration
 - Bioremediation
 - Dechlorination
 - Vitrification
 - UV Oxidation

CONTAINMENT TECHNOLOGIES:

In-situ

- Cap
- Permeable Barrier
- Slurry Wall
- Solidification
- Vitrification
- Ground Freezing
- Soil Mixing/Stabilization

Ex-situ

- Solidification
- RCRA Vault
- Vitrification

SEPARATION TECHNOLOGIES:

In-situ

- Vacuum Extraction
- Soil Flushing
- Steam Injection/Vacuum Extraction
- Air Sparging
- CROW Process

Ex-situ

- Granular Activated Carbon
- Algasorb
- Reverse Osmosis
- Air Stripping
- Membrane Microfiltration
- Wetland Board
- Ion Exchange
- Precipitation
- Soil Washing
- Thermal Desorption
- Solvent Extraction
- Acid Extraction
- Centrifugal Jig
- Magnetic Separation
- Sorption/Filtration

SUPPORT TECHNOLOGIES:

In-situ

- Bubbleless Aeration
- Radio Frequency Heating
- Air Sparging
- Pneumatic Fractures
- Soil Mixing

Ex-situ

- Surfactants

Section 5

APPENDICES

Suggested Report Formats
Remedial Investigation Report
Remedial Alternatives Analysis Report

Summary of ARs

**Risk Based Corrective Action and Decision Making at Sites with
Contaminated Soil and Ground Water
(HDOH Policy, Volume 1)**

Guidelines for Tier 3 Human Health Risk Assessment

Appendix 5A

Suggested Report Format for Remedial Investigation Report

APPENDIX 5A
SUGGESTED FORMAT FOR REMEDIAL INVESTIGATION
REPORT

I COVER PAGE

Provide facility name and address. If available, provide latitude and longitude coordinates.

Date report was prepared

Name, address and telephone number of person/company preparing the report

II TABLE OF CONTENTS

III EXECUTIVE SUMMARY

A brief summary/overview of the important results and findings of the remedial investigation, initial response, field measurements, free product removal, and media specific (soil, groundwater) investigation activities. Conclusions and recommendations for further (if any) work should also be presented.

IV INTRODUCTION/PURPOSE

Brief Statement of Purpose

V BACKGROUND

Site Description - a brief description of the site location and surrounding area. The location of any populations that could be affected by the site.

Vicinity Map or Sketch - with north arrow, streets, surface water bodies and water supply or injection wells clearly marked.

A USGS 7.5 minute topographic quadrangle map indicating the location of the site.

Site Plan(s) drawn to scale showing details of the following:

The type and extent of onsite, ground surface cover (i.e., asphalt, concrete, soil, etc)

Locations of all products and waste products tanks, storage areas, etc.

Adjacent streets, buildings, and property lines

Utility Conduits

Facility Information

A brief history of the site ownership/operation

Results of initial surficial inspection of the area

Description of the processes and products used at the site

Types of products used and histories of releases -- including estimations of volume, and initial response.

Previous Investigations

A brief summary of the results of any previous investigations

VI STUDY AREA INVESTIGATION

Includes field activities associated with site characterization. If technical memorandum were prepared, they may be included in an appendix and summarized in this chapter. These may include physical and chemical monitoring of some, but not necessarily all, of the following:

Surface Features

Contaminants Source Investigations

Meteorological Investigations

Surface Water and Sediment Investigations

Geological Investigations

Soil and Vadose Zone Investigations

Groundwater Investigations

Human Population Surveys

Ecological Investigations

Cross-sectional diagrams showing the specific locations and depth of the sampling.

Describe the site sampling procedures undertaken to collect and analyze all media.

Describe or cite sample control procedures followed, including types of sample collection containers used and method of appropriate sample preservation.

Discuss Chain of Custody.

Discuss Field Measurements: Instrumentation, Calibration, response, and procedures.

Present Table of Field Measurement Results keyed to sample locations and the site plan.

Laboratory Analytical Results: Present a Table of Results with sample ID, location (keyed to site plan) including sample depths, preparation and analysis methods, constituent concentration and method detection limits. All tabulated results should be expressed in parts per million (mg/kg or mg/L).

Formal Analytical Results should be an appendix to the report. Results must be reported on laboratory letterhead and include the following:

Date sampled, received (by all parties), extracted, analyzed, and reported.

Condition of samples upon receipt by laboratory

Methods of preparation (extraction) and analysis

Detection Limits

Concentration of analyte, in ppm

QA/QC protocol should include:

- Field and reagent blank

- Matrix spike and matrix spike duplicate

- Calibration check standard

- Surrogate recoveries

- Acceptable ranges

- Signature of analytical testing personnel and the lab director/manager

- A summary of the Data Quality Assessment should be provided for each sampling event.

VII PHYSICAL CHARACTERISTICS OF THE SITE

Includes results of field activities to determine physical characteristics. These may include some, but not necessarily all, of the following:

- Surface Features

- Meteorology

- Surface Water Hydrology

Geology
Soils
Hydrogeology
Demography and Land Use
Ecology

A concise description of both the regional and localized geology including: soil and bedrock lithology, stratigraphy, and structural geology as determined through soil borings, excavation, rock cores, maps and other sources.

A site plan identifying the locations of all soil borings and groundwater monitoring wells.

At least two representative cross-sections should be included in the report. The cross sections should illustrate, at a minimum: fresh, brackish and saltwater elevations; well screen lengths, total depth of penetrations, lithology and or stratigraphy intercepted, including continuity or discontinuity of those lithologies; important structural feature, if present, all surface topography; important natural and cultural locations (ponds, streams, rivers, swamps, highways, buildings, foundations, etc.) and the horizontal and vertical extent of contamination.

A copy of the boring logs and all other pertinent information, such as photos or diagrams of excavations should be included.

Based on literature, maps, and field, test, and core data a representative and accurate classification of the regional and localized hydrology including:

Known or recorded depth to groundwater

Representative description of water/fluid pressure as indicated in water-level (head) contour and/or potentiometric maps. The flow system should show the horizontal component of flow and any temporal changes in hydraulic gradient due to either manmade or naturally occurring influences.

The direction, estimated volume, and estimated velocity of groundwater flow.

The characteristics of the uppermost aquifer, including the nature of the aquifer (i.e., caprock, basal, perched, or dike-confined), interconnections, aquifer use, and salinity or conductivity. If aquifer tests are performed, discussion should include the well location and completion details, test methods used and calculation used.

Characterization of the surface water bodies within 1/4 mile of the facility.

Potential area of groundwater recharge and discharge including manmade and

natural features.

A discussion of the available published climatological data for the site area, including monthly average precipitation and seasonal variations of precipitation which could influence contamination fate and migration.

VIII NATURE AND EXTENT OF CONTAMINATION

Presents the results of the site characterization, both natural chemical components and contaminants in some, but not necessarily all, of the following media:

- Sources (lagoons, sludges, tanks, etc.)
- Soils and Vadose Zone
- Groundwater
- Surface Water and Sediments
- Air

IX CONTAMINANT FATE AND TRANSPORT

Potential Routes of Migration

Contaminant Persistence - If they are applicable, describe estimated persistence in the study area environmental and physical, chemical, and/or biological factors of importance for the media of interest.

Contaminant Migration - Discuss factors affecting contaminant migration for the media of importance. Discuss modeling methods and results, if applicable.

The type, magnitude and extent of soil and water contaminants at the facility should be completely characterized. This characterization should include, at a minimum:

Complete characterization, in both the horizontal and vertical extent, by media and phase. Including:

- A summary table of results of all samples of soil and water with sample locations keyed to plan map(s)

A plan map(s) illustration the areal extent of contamination by media and phase

At least two representative cross sections depicting the vertical extent of contamination by media and phase.

Copies of all laboratory data forms and associated QA/QC documentation as an appendix to the report.

X RISK ASSESSMENT PROCEDURES

Include the Tier I, II, or III Worksheet with follow up documentation. If EPA RAGS is followed, provide all information required by that process: Exposure Assessment, Toxicity Assessment, and Risk Characterization. Provide any ecological risk evaluation information.

XI SUMMARY AND CONCLUSIONS

Include a summary of the nature and extent of contamination, fate and transport, and risk assessment. Include any conclusions regarding data limitations and recommendations of future work. Also, recommendations for remedial action objectives.

XII APPENDICES

Appendix 5A2

Suggested Report Format for Remedial Alternative Analysis Report



APPEXDIX 5A2

SUGGESTED FORMAT FOR REMEDIAL ALTERNATIVE ANALYSIS REPORT

I COVER PAGE

Provide Facility Name and Address. If available, provide latitude and longitude coordinates.

Date the report was prepared

Name, Address, and Telephone number of person/company preparing the report

II TABLE OF CONTENTS

III EXECUTIVE SUMMARY

A brief summary/overview of the important findings of the alternatives evaluations of technologies and the agreement with the remedial action objectives and ARs.

IV PURPOSE AND ORGANIZATION OF REPORT

A brief statement of purpose

V BACKGROUND INFORMATION

This information should be an update or summary of the information provided in the Remedial Investigation Report, including: Site Description, Site History, Nature and Extent of Contamination, Contaminant Fate and Transport, and Evaluation of Risk.

VI IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Introduction

Remedial Action Objectives - Presents the development of remedial action objectives for each medium of interest (i.e., groundwater, soil, surface water, air, etc.). For each medium, the following should be discussed:

Contaminants of Interest

Allowable exposure based on risk assessment(including ARs)

Development of Remedial Goals

General Response Actions - For each medium of interest, describe the estimation of areas or volumes to which treatment, containment, or exposure technologies may be applied.

Identification and Screening of Technology Types and Process Options - For each medium of interest, describes:

Identification of Screening Technologies

Evaluation of Technologies and Selection of Representative Technologies

VII DEVELOPMENT AND SCREENING OF ALTERNATIVE

Development of Alternatives - Describes the rationale for combination of technologies/media into alternatives. This discussion may be by medium or for the site as a whole.

Screening of Alternatives - each alternative shall be described in detail, which simple drawings and evaluated.

VIII DETAILED ANALYSIS OF ALTERNATIVES

Each alternative shall be analyzed on a detailed basis for each of the criteria.

Comparative Analysis

IX BIBLIOGRAPHY

X APPENDICES

Appendix 5B

Summary of ARs

SUMMARY OF DEPARTMENT OF HEALTH ARs

| AR Type | Site Investigation Characteristic Affected by AR | Goals and Requirements | Prerequisites for Applicability | AR Citation |
|----------|--|---|---|--|
| Location | Inland and marine waters | <p>To ensure protection of beneficial uses of State waters; Prohibits waste discharge into designated protected waters; Requires best degree of treatment or control for waste discharged into all surface waters; Prohibits new sewage and industrial discharges within estuaries and embayments, with the exception of acceptable non-contact thermal and floating drydock or marine railway discharges within specified geographic locations; Requires monitoring of all State waters for basic water quality criteria, acute and chronic toxicity and the protection of human health; Requires DOH certification of discharge permits</p> | <p>All fresh, brackish, or salt waters around or within the Hawaiian Archipelago including appurtenant reefs and waters except for the Midway Islands</p> | <p>Hawaii Water Quality Standards, Hawaii Administrative Rules, Title 11, Chapter 54</p> |
| Action | Discharge of any substance into State waters or from a treatment works or waste outlet | <p>Requires a National Pollutant Discharge Elimination System (NPDES) permit for discharging any pollutant or substantially altering the quality or quantity of any discharge; Requires that the director issue or renew a NPDES permit for a period not exceeding five years and on the basis that the existing or new treatment works or waste outlet is designed, built, and equipped in accordance with the requirements of this chapter; Requires public participation in the permitting process</p> | <p>Any substance discharged into State waters or from publicly owned treatment works or sewerage systems, including but not limited to sewage, waste, garbage, feculent matter, offal, filth, refuse, any animal, mineral or vegetable matter or substance, and any liquid, gaseous or solid substances</p> | <p>Hawaii Water Pollution Control Regulations, Hawaii Administrative Rules, Title 11, Chapter 55</p> |

SUMMARY OF DEPARTMENT OF HEALTH ARs (continued)

| AR Type | Site Investigation Characteristic Affected by AR | Goals and Requirements | Prerequisites for Applicability | AR Citation |
|---------|---|---|---|--|
| Action | Disposal of solid waste | Requires DOH approval for permits and variances | The discharge, deposit, injection, dumping, spilling, leaking or placing of any solid waste onto any land or water so that such solid waste, or any constituent thereof, may enter the environment, be emitted into the air, or discharged into any water, including ground waters | Hawaii Solid Waste Pollution Act, Hawaii Revised Statutes, Title 19, Chapter 342H |
| Action | The design, construction, installation, operation and maintenance of solid waste disposal systems | Requires permits for the establishment, modification or operation of any solid waste disposal facility; Solid waste shall be deposited in a sanitary manner to prevent waste materials, leachate, or eroded soil particles from entering the waters of the State without receiving the best practicable treatment or control; Toxic, caustic, volatile and flammable chemical waste shall be rendered nonhazardous by chemical neutralization or stabilization prior to final disposal; The disposal of chemical wastes at a landfill shall be in a specially constructed trench or pit that is designed to retain the wastes and prevent infiltration into ground or surface waters; Experimental and restricted use pesticides shall be incinerated or chemically deactivated, encapsulated and buried in a specially designated trench or pit in a landfill, or temporarily stored pending final detoxification and disposal | Garbage, refuse, and other discarded solid materials, including solid waste materials resulting from industrial and commercial operations, and from community activities, liquid waste materials such as waste oil, pesticides, paints, solvents and hazardous wastes (Note: the UST program is currently enforcing the solid waste disposal facility permit requirement for off-site treatment and disposal facilities associated with remedial cleanup actions) | Hawaii Solid Waste Management Control Standards, Hawaii Administrative Rules, Title 11, Chapter 58 |

SUMMARY OF DEPARTMENT OF HEALTH ARs (continued)

| AR Type | Site Investigation Characteristic Affected by AR | Goals and Requirements | Prerequisites for Applicability | AR Citation |
|---------------------|---|--|---|---|
| Action/ Location | Disposal of wastewater from wastewater treatment works | To ensure that the disposal of wastewater does not contaminate or pollute any valuable water resource, does not give rise to public nuisance, and does not become a hazard or potential hazard to the public health, safety and welfare; Allows the enforcement of higher effluent standards, limiting the method of effluent disposal and requiring flow restriction devices on water fixtures in designated critical wastewater disposal areas (CWDA); wastewater sludge shall only be disposed of by a permitted solid waste facility, by reclamation or reuse for agricultural purposes, by incineration or by a wastewater system which has been authorized to accept and dispose of sludge | Any liquid waste, whether treated or not, and whether animal, mineral or vegetable, including agricultural, industrial and thermal wastes. | Hawaii Wastewater Systems Regulations, Hawaii Administrative Rules, Title 11, Chapter 62 |
| Action | Disruption or contamination of drinking water supplies | Requires DOH to coordinate with other governmental agencies and the private sector to provide safe drinking water during emergency situations | Covers all major and limited situation emergencies which disrupt water systems or interfere with quantity and quality of water delivered to the public | Hawaii Emergency Plan for safe Drinking Water, Hawaii Administrative Rules, Title 11, Chapter 21 |

SUMMARY OR DEPARTMENT OF HEALTH ARs (continued)

| AR Type | Site Investigation Characteristic Affected by AR | Goals and Requirements | Prerequisites for Applicability | AR Citation |
|---------------------|--|--|---|---|
| Location | Public water systems | Requires monitoring for compliance with Maximum Contaminant Levels (MCLs); Establishes sampling, analytical, reporting and records maintenance requirements; Requires that the granting of variances or exemptions will not result in an unreasonable risk to the health of persons served by the system; Requires public notification whenever a water system fails to comply with an applicable MCL, treatment technique, monitoring or testing procedure, is subject to a variance or exemption, or fails to comply with the requirements of any schedule prescribed pursuant to such variance or exemption | Covers any public water system unless the system consists only of distribution and storage facilities, obtains all of its water from, but is not owned or operated by, a public water system to which such regulations apply does not sell water to any person and is not a carrier which conveys passengers in interstate commerce | Hawaii Potable Water Systems Regulations, Hawaii Administrative Rules, Title 11, Chapter 20 |
| Location/ Action | Cross-connections between a public water system and any secondary water system | To protect the public water systems by isolation of contaminants within them which could backflow or backsiphon into and contaminate potable water; To promote the elimination or control of existing cross-connections, actual or potential, between potable and non-potable water systems, plumbing fixtures and industrial piping systems; To maintain a continuing program of cross-connection control which will prevent the contamination of all potable water systems | All existing cross-connections between potable and non-potable water systems | Hawaii Cross-Connection and Backflow Control Ordinance, Hawaii Administrative Rules, Title 11, Chapter 21 |

SUMMARY OF DEPARTMENT OF HEALTH ARs (continued)

| AR Type | Site Investigation Characteristic Affected by AR | Goals and Requirements | Prerequisites for Applicability | AR Citation |
|----------|---|---|---|--|
| Location | The location, construction and operation of injection wells | <p>To protect the quality of the State's current and future underground sources of drinking water (USDW);</p> <p>Requires permit to construct and operate an injection well;</p> <p>Prohibits wells which inject hazardous, radioactive, mining and municipal waste fluids into any USDW or exempted aquifer; Prohibits the construction of new sewage injection or industrial disposal wells which inject fluids into any non-exempted aquifer;</p> <p>Requires any new injection well to be cited beyond an area which extends at least one-quarter mile from any part of a drinking water source;</p> <p>Requires grouting or some other acceptable technique to preserve the integrity of the confining zone or zones when undesirable mixing of fluids occurs due to improper well construction or use of an injection well; Requires inspection, monitoring and recordkeeping activities;</p> <p>Requires public hearings for proposed injection wells above the UIC Line</p> | <p>Covers all wells which inject fluids into any geohydrologic formation, including underground sources of drinking water and exempted aquifers; An aquifer is exempted from USDW status if it does not currently serve as a source of drinking water and will not be a future source of drinking water because recovery is technologically or economically infeasible, it is so contaminated that it would be impractical to render it fit for human consumption or the total dissolved solids concentration of the groundwater is more than 5,000 mg/l (as contrasted with the 10,000 mg/l standard established under the federal UIC program); UIC maps shall indicate exempted aquifers and USDW by use of a UIC Line</p> | <p>Hawaii Underground Injection Control Standards, Hawaii Administrative Rules, Title 11, Chapter 23</p> |

SUMMARY OF DEPARTMENT OF HEALTH ARs (continued)

| AR Type | Site Investigation Characteristic Affected by AR | Goals and Requirements | Prerequisites for Applicability | AR Citation |
|----------|--|---|--|--|
| Action | Minimization, reduction, recycling, exchange and disposal of hazardous waste | To ensure that hazardous waste is managed in a manner that protects the health, safety and welfare of the citizens of the State and protects and conserves the State's natural resources and environment; Requires permit to treat, store and dispose of hazardous waste | Any discharge, deposit, injection, dumping, spilling, leaking, or placing of any hazardous or solid waste on or into any land or water so that hazardous or solid waste or any constituent thereof that may enter the environment, be emitted into the air or be discharged into any waters including ground water | Hawaii Hazardous Waste Management Act, Hawaii Revised Statutes, Title 19, Chapter 342J |
| Action | Ground waters, surface waters, marine waters, drainage systems and soil | No new oil, used oil, or recycled oil shall be discharged or caused or allowed to enter into sewers, drainage systems, surface or ground waters, water courses, marine waters or onto the ground; No person shall transport, market or recycle used oil except by permit; All transporters, receivers, recyclers and burners of used oil must invoice all transactions; Used oil which exceeds halogen concentrations of 1,000 ppm must be disposed of as hazardous waste | Covers all new, used and recycled oil discharged in the State; Covers all used or recycled oil transported within the State | Hawaii Used Oil Act, Hawaii Revised Statutes, Title 19, Chapter 342N |
| Location | Underground storage tank installation, operation and maintenance | Requires that when a leak is found the substance in tank be emptied if emptying the substance does not constitute a greater environmental or health danger; Requires proper repair and testing of tank before return to service; Requires restoration of environment to a condition and quality acceptable to DOH | Covers any underground storage tanks or combinations of tanks and piping in use or brought into use on or after May 19, 1986, which are used for the storage, use or dispensing of regulated substances, and the volume of which is ten percent or more beneath the ground | Hawaii Underground Storage Tanks Act, Hawaii Revised Statutes, Title 19, Chapter 342L |

SUMMARY OF DEPARTMENT OF HEALTH ARs (continued)

| AR Type | Site Investigation Characteristic Affected by AR | Goals and Requirements | Prerequisites for Applicability | AR Citation |
|---------------------|---|---|--|---|
| Action/ Location | Air pollution | No person shall engage in, cause, allow, or maintain any activity which causes air pollution without first securing written approval from the director; Requires permits for point sources and treatment systems; Exemption from the requirement of authority to construct or permit to operate shall not relieve the person from fully complying with all applicable state and county laws or rules, or federal laws and regulations; Except for exempted underground tanks, requires that a container of more than 40,000 gallon capacity which stores any volatile organic compound be capable of maintaining working pressures sufficient at all times to prevent vapor or gas loss to the atmosphere or be equipped with a gas-tight floating roof or a vapor recovery system; Requires the use of smokeless flares or an equally effective device approved by the director to burn a gas stream containing volatile organic compounds emitted from a vapor blowdown system or for the purpose of emergency relief | Includes air pollution caused by visible emissions, fugitive dust, incineration, process industries, sulfur oxides from fuel combustion, storage of volatile organic compounds, volatile organic compound water separation, and waste gas disposal | Hawaii Air Pollution Control Standards, Hawaii Administrative Rules, Title 11, Chapter 60 |
| Location/ Action | Public health nuisances | To provide minimum standards of sanitation so that public health and human welfare will be protected, and safety hazards will be minimized | Covers any condition which may have an adverse effect on public health, which exists or occurs within the State, or on board of any vessel within the jurisdiction of the State | Hawaii Sanitation Regulation, Hawaii Administrative Rules, Title 11, Chapter 11 |

SUMMARY OF OTHER DEPARTMENTS' ARs

| AR Type | Site Investigation Characteristic Affected by AR | Goals and Requirements | Prerequisites for Applicability | AR Citation |
|---------------------|---|--|---|--|
| Action | Air | To ensure employers implement applicable procedures for the protection of employees against exposure or the reasonable possibility of exposure to safety and health risks during hazardous substance cleanup operations and hazardous waste operations pursuant to RCRA and during emergency response operations regarding hazardous substances | Applies only to employee exposure to airborne concentrations of hazardous substances, not pollution levels. | Hawaii Occupational Safety and Health Standard, Hawaii Administrative Rules, Title 12, Chapter 99 |
| Action/ Location | Endangered and threatened species | Prohibits the taking (harassment, harming or killing), export, possession, selling, delivery, carrying, or transporting of any endangered species; Prohibits the violation of any rule pertaining to the conservation of such species or to any threatened species; Allows the issuance of temporary licenses to exempt certain prohibited actions for scientific purposes or to enhance the propagation or survival of the affected species | Applies to any endangered or threatened species of aquatic life, wildlife, or land plant | Hawaii Endangered and Threatened Species Regulations, Hawaii Administrative Rules, Title 13, Part II, Chapters 122 and 124 |
| Action/ Location | Wild bird species | Prohibits the taking of any wild bird species without obtaining a permit from DLNR | Applies to all wild bird species in the state, including native, introduced and pest species | Hawaii Conservation Regulations, Hawaii Administrative Rules, Title 13, Part II, Chapter 124 |

TITLE 11 DEPARTMENT OF HEALTH CHAPTER 54 WATER QUALITY STANDARDS NUMERIC STANDARDS FOR TOXIC POLLUTANTS APPLICABLE TO ALL WATERS (all values are expressed in $\mu\text{g/L}$ or ppb)

| POLLUTANT | FRESHWATER ACUTE | FRESHWATER CHRONIC | SALTWATER ACUTE | SALTWATER CHRONIC | FISH CONSUMPTION |
|----------------------------|------------------|--------------------|-----------------|-------------------|------------------|
| Acenaphthene | 570 | ns | 320 | ns | ns |
| Acrolein | 23 | ns | 18 | ns | 250 |
| Acrylonitrile* | 2500 | ns | ns | ns | 0.21 |
| Aldrin* | 3 | ns | 1.3 | ns | 0.000026 |
| Aluminum | 750 | 260 | ns | ns | ns |
| Antimony | 3000 | ns | ns | ns | 15000 |
| Arsenic | 360 | 190 | 69 | 36 | ns |
| Benzene* | 1800 | ns | 1700 | ns | 13 |
| Benzidine* | 800 | ns | ns | ns | 0.00017 |
| Beryllium* | 43 | ns | ns | ns | 0.038 |
| Cadmium | 3+ | 3+ | 43 | 9.3 | ns |
| Carbon tetrachloride* | 12000 | ns | 16000 | ns | 2.3 |
| Chlordane* | 2.4 | 0.0043 | 0.09 | 0.004 | 0.000016 |
| Chlorine | 19 | 11 | 13 | 7.5 | ns |
| Chloroethers-ethyl(bis-2)* | ns | ns | ns | ns | 0.44 |
| Chloroethers-isopropyl | ns | ns | ns | ns | 1400 |
| Chloroethers-methyl(bis)* | ns | ns | ns | ns | 0.44 |
| Chloroform* | 9600 | ns | ns | ns | 5.1 |
| Chlorophenol (2) | 1400 | ns | ns | ns | ns |

| POLLUTANT | FRESHWATER ACUTE | FRESHWATER CHRONIC | SALTWATER ACUTE | SALTWATER CHRONIC | FISH CONSUMPTION |
|------------------------|---------------------|-----------------------|--------------------|----------------------|----------------------|
| Chlorpyrifos | 0.083 | 0.041 | 0.011 | 0.0056 | ns |
| Chromium (VI) | 16 | 11 | 1100 | 50 | ns |
| Copper | 6+ | 6+ | 2.9 | 2.9 | ns |
| Cyanide | 22 | 5.2 | 1 | 1 | ns |
| DDT* | 1.1 | 0.001 | 0.013 | 0.001 | 0.000008 |
| DDT metabolite TDE* | 0.03 | ns | 1.2 | ns | ns |
| Demeton | ns | 0.1 | ns | 0.1 | ns |
| Dichloro-benzenes** | 370 | ns | 660 | ns | 850 |
| Dichloro-benzidine* | ns | ns | ns | ns | 0.007 |
| Dichloro-ethane(1,2)* | 39000 | ns | 75000 | ns | 0.6 |
| Dichloro-ethylene(1,1) | 3900 | ns | 75000 | ns | 0.6 |
| Dichloro-phenol(2,4) | 670 | ns | ns | ns | ns |
| Dichloro-propanes | 7700 | ns | 3400 | ns | ns |
| Dichloro-propene(1,3) | 2000 | ns | 260 | ns | 4.6 |
| Dieldrin* | 2.5 | 0.0019 | 0.71 | 0.0019 | 0.000025 |
| Dinitro-o-cresol(2,4) | ns | ns | ns | ns | 250 |
| Dinitrotoluenes* | 110 | ns | 200 | ns | 3 |
| Dioxin* | 0.003 | ns | ns | ns | 5.0×10^{-9} |
| Diphenylhydrazine(1,2) | ns | ns | ns | ns | 0.018 |
| Endosulfan | 0.22 | 0.0056 | 0.034 | 0.0087 | 52 |

| POLLUTANT | FRESHWATER ACUTE | FRESHWATER CHRONIC | SALTWATER ACUTE | SALTWATER CHRONIC | FISH CONSUMPTION |
|----------------------------------|---------------------|-----------------------|--------------------|----------------------|---------------------|
| Endrin | 0.18 | 0.0023 | 0.034 | | |
| Ethylbenzene | 11000 | ns | 140 | ns | 18 |
| Fluoranthene | 1300 | ns | 13 | ns | 18 |
| Guthion | ns | 0.01 | ns | 0.01 | ns |
| Heptachlor* | 0.52 | 0.0038 | 0.053 | 0.0036 | 0.00009 |
| Hexachlorobenzene* | ns | ns | ns | ns | 0.00024 |
| Hexachlorobutadiene* | 30 | ns | 11 | ns | 16 |
| Hexachlorocyclohexane-alpha* | ns | ns | ns | ns | 0.01 |
| Hexachlorocyclohexane-beta* | ns | ns | ns | ns | 0.018 |
| Hexachlorocyclohexane-technical* | ns | ns | ns | ns | 0.014 |
| Hexachlorocyclopentadiene | 2 | ns | 2 | ns | ns |
| Hexachloroethane* | 330 | ns | 310 | ns | 2.9 |
| Isophorone | 39000 | ns | 4300 | ns | 170000 |
| Lead | 29+ | 29+ | 140 | ns | ns |
| Lindane* | 2 | 0.08 | 0.16 | ns | 0.02 |
| Malathion | ns | 0.1 | ns | 0.1 | ns |
| Mercury | 2.4 | 0.55 | 2.1 | ns | ns |
| Methoxychlor | ns | 0.03 | ns | 0.03 | ns |
| Mirex | ns | 0.001 | ns | 0.001 | ns |
| Naphthalene | 770 | ns | 780 | ns | ns |

| POLLUTANT | FRESHWATER ACUTE | FRESHWATER CHRONIC | SALTWATER ACUTE | SALTWATER CHRONIC | FISH CONSUMPTION |
|---------------------------------|---------------------|-----------------------|--------------------|----------------------|---------------------|
| Nickel | 5+ | 5+ | 75 | 8.3 | 33 |
| Nitrobenzene | 9000 | ns | 2200 | ns | ns |
| Nitrophenols | 77 | ns | 1600 | ns | ns |
| Nitrosamines* | 1950 | ns | ns | ns | 0.41 |
| Nitrosodibutylamine-N* | ns | ns | ns | ns | 0.19 |
| Nitrosodiethylamine-N* | ns | ns | ns | ns | 0.41 |
| Nitrosodimethylamine-N* | ns | ns | ns | ns | 5.3 |
| Nitrosodiphenylamine-N* | ns | ns | ns | ns | 5.3 |
| Nitrosopyrrolidine-N* | ns | ns | ns | ns | 30 |
| Parathion | 0.065 | 0.013 | ns | ns | ns |
| Pentachloroethanes | 2400 | ns | 130 | ns | ns |
| Pentachlorobenzene | ns | ns | ns | ns | 28 |
| Pentachlorophenol | 20 | 13 | 13 | ns | ns |
| Phenol | 3400 | ns | 170 | ns | ns |
| Phenol 2,4-dimethyl | 700 | ns | ns | ns | ns |
| Phthalate ester-dibutyl | ns | ns | ns | ns | 50000 |
| Phthalate ester-diethyl | ns | ns | ns | ns | 590000 |
| Phthalate ester-di-2-ethylhexyl | ns | ns | ns | ns | 16000 |
| Phthalate ester-dimethyl | ns | ns | ns | ns | 950000 |
| Polychlorinated biphenyls* | 2 | 0.014 | 10 | 0.03 | 0.000079 |

| POLLUTANT | FRESHWATER ACUTE | FRESHWATER CHRONIC | SALTWATER ACUTE | SALTWATER CHRONIC | FISH CONSUMPTION |
|---|---------------------|-----------------------|--------------------|----------------------|---------------------|
| Polynuclear aromatic hydrocarbons* (PAHs) | ns | ns | ns | ns | 0.01 |
| Selenium | 20 | 5 | 300 | 71 | ns |
| Silver | 1+ | 1+ | 2.3 | ns | ns |
| Tetrachloroethanes | 3100 | ns | ns | ns | ns |
| Tetrochlorobenzene(1,2,4,5) | ns | ns | ns | ns | 16 |
| Tetrochloroethane(1,1,2,2)* | ns | ns | 3000 | ns | 3.5 |
| Tetrochloroethylene* | 1800 | ns | 3400 | 145 | 2.9 |
| Tetrochlorophenol(2,3,5,6) | ns | ns | ns | 440 | ns |
| Thallium | 470 | ns | 710 | ns | 16 |
| Toluene | 5800 | ns | 2100 | ns | 140000 |
| Toxaphene* | 0.73 | 0.0002 | 0.21 | 0.0002 | 0.00024 |
| Trichloroethane(1,1,1) | 6000 | ns | ns | ns | 14 |
| Trichloroethane(1,1,2)* | 6000 | ns | ns | ns | 26 |
| Trichloroethylene* | 15000 | ns | 700 | ns | 26 |
| Trichlorophenol(2,4,6)* | ns | ns | ns | ns | 1.2 |
| Vinyl chloride* | ns | ns | ns | ns | 170 |
| Zinc | 22+ | 22+ | 95 | 86 | ns |

Notes: All values are expressed in µg/L or ppb.

ns = No standard has been developed.

* = Carcinogen

+ = The value listed is the minimum standard. Depending upon the receiving water hardness, higher standards may be calculated using the respective formula in the U.S. EPA publication Quality Criteria for Water (EPA 440/5-86-001, Revised May 1, 1987).

**TITLE 11 DEPARTMENT OF HEALTH CHAPTER 20 POTABLE WATER SYSTEMS
MAXIMUM CONTAMINANT LEVELS FOR DRINKING WATER**

1. VOLATILES

| CONTAMINANT | MAXIMUM CONTAMINANT LEVEL |
|--------------------------------|---------------------------|
| 1,1 Dichloroethylene | 7 µg/L |
| 1,1,1 - Trichloroethane | 200 µg/L |
| 1,1,2 - Trichloroethane | 5 µg/L |
| 1,2 - Dichloroethane | 5 µg/L |
| 1,2 - Dichloropropane | 5 µg/L |
| Benzene | 5 µg/L |
| Carbon Tetrachloride | 5 µg/L |
| cis - 1,2 - Dichloroethylene | 70 µg/L |
| Dichloromethane | 5 µg/L |
| Ethylbenzene | 700 µg/L |
| Monochlorobenzene | 100 µg/L |
| ortho-Dichlorobenzene | 600 µg/L |
| para-Dichlorobenzene | 75 µg/Lµg/L |
| Styrene | 100 µg/L |
| Tetrachloroethylene (PCE) | 5 µg/L |
| Toluene | 1000 µg/L |
| trans - 1,2 - Dichloroethylene | 100 µg/L |
| Trichloroethylene (TCE) | 5 µg/L |
| Vinyl Chloride | 2 µg/L |
| Xylenes | 10,000 µg/L |
| DBCP | 0.04 µg/L |
| EDB | 0.04 µg/L |
| TCP | 0.8 µg/L |

**TITLE 11 DEPARTMENT OF HEALTH CHAPTER 20 POTABLE WATER SYSTEMS
MAXIMUM CONTAMINANT LEVELS FOR DRINKING WATER (continued)**

2. INORGANICS

| CONTAMINANT | MAXIMUM CONTAMINANT LEVEL |
|-------------------------|---------------------------|
| Arsenic | 50 µg/L |
| Asbestos | 7 MFL |
| Barium | 2 mg/L |
| Cadmium | 5 µg/L |
| Chromium | 100 µg/L |
| Lead | 15 µg/L (Action Level) |
| Mercury | 0.002 mg/L |
| Nitrate (as N) | 10 mg/L |
| Nitrite (as N) | 1 mg/L |
| Total Nitrate + Nitrite | 10 mg/L |
| Selenium | 50 µg/L |

3. PESTICIDES/SYNTHETIC ORGANIC CHEMICALS

| CONTAMINANT | MAXIMUM CONTAMINANT LEVEL |
|--------------------|---------------------------|
| Alachlor | 2 µg/L |
| Atrazine | 3 µg/L |
| Endrin | 2 µg/L |
| Lindane | 0.2 µg/L |
| Methoxychlor | 40 µg/L |
| Chlordane | 2 µg/L |
| Heptachlor | 0.4 µg/L |
| Heptachlor Epoxide | 0.2 µg/L |
| Toxaphene | 3 µg/L |
| PCBs | 0.5 µg/L |

4. HERBICIDES

| CONTAMINANT | MAXIMUM CONTAMINANT LEVEL |
|---------------------|---------------------------|
| 2,4 - D | 70 $\mu\text{g/L}$ |
| 2,4,5 - TP (Silvex) | 50 $\mu\text{g/L}$ |
| Pentachlorophenol | 1 $\mu\text{g/L}$ |

HAWAII ARs MORE STRINGENT THAN THEIR FEDERAL COUNTERPARTS

In the process of conducting a remedial action, those applicable state ARs more stringent than their federal counterparts will determine the necessary cleanup endpoints to be met at a site.

Those Hawaii ARs that are more stringent than their federal counterparts, are designed to be more protective of unique resources and vulnerable targets and, as such, should be of the utmost concern in cleanup processes in order to address the state's specific concerns.

SUMMARY OF HAWAII ARs MORE STRINGENT THAN FEDERAL REQUIREMENTS

The following table summarizes the different between Hawaii's more stringent ARs and their federal counterparts.

| Hawaii AR | Federal Counterpart |
|---|---|
| (1) Hawaii Underground Injection Control Standards, HAR 11-23, threshold for defining what constitutes drinking water: Ground water containing more than 5,000 mg/L total dissolved solids is exempted from underground source of drinking water (USDW) status. | Federal UIC Program, Section 40 CFR 144.3, threshold for defining what constitutes drinking water: Groundwater containing more than 10,000 mg/L total dissolved solids is exempted from USDW status. |
| (2) Hawaii Ambient Air Quality Standards, HAR 11-59: One-hour average of carbon monoxide not to exceed 10.0 mg/m ³ ; 8-hour average not to exceed 5.0 mg/m ³ . Twelve-month average of nitrogen dioxide not to exceed 70.0 µg/m ³ . | National Ambient Air Quality Standards, 40 CFR 50.8 & 50.11: One-hour average of carbon monoxide not to exceed 40.0 mg/m ³ ; 8-hour average not to exceed 10.0 mg/m ³ . Twelve-month average of nitrogen dioxide not to exceed 100.0 µg/m ³ . |
| (3) Proposed MCLs to be incorporated in Hawaii Potable Water Systems Regulations, HAR 11-20: DBCP = 40 parts per trillion EDB = 40 parts per trillion TCP = 800 parts per trillion | MCLs under EPA Phase II Synthetic Organic Chemical and Inorganic Chemical Standards: DBCP = 200 parts per trillion EDB = 50 parts per trillion TCP = no standard exists |
| (4) Endangered and threatened species listed under HAR 13, Part II, Titles 122 and 124, Department of Land and Natural Resources, Division of Fish and Wildlife: | Status under the Endangered Species Act, 16 USC Sections 1531-1543, and the Migratory Bird Treaty Act: |

**SUMMARY OF HAWAII ARs MORE STRINGENT THAN FEDERAL REQUIREMENTS
(continued)**

| Hawaii AR | Federal Counterpart |
|---|---|
| Band-rumped Storm-Petrel, (Also known as Harcourt Storm- Petrel and Hawaiian Storm-Petrel), 'Oe 'Oe, <u>Oceanodroma castro crytoleucura</u> : listed as endangered on Kauai, its only known breeding range in the state | Band-rumped Storm-Petrel: no status under ESA, protected by MBTA |
| Hawaiian Owl, Pueo <u>Asio flammeus sandwichensis</u> : listed as endangered on Oahu; known breeding range includes Hawaii, Maui and Molokai | Hawaiian Owl: no federal status |
| Maui 'Amakihi, <u>Hemignathus virens wilsoni</u> : listed as endangered on Lanai; known breeding range also includes Maui and Molokai | Maui 'Amakihi: no federal status |
| 'I'iwi <u>Vestiaria coccinea</u> : listed as endangered on Oahu, Molokai and Lanai; known breeding range also includes Hawaii | 'I'iwi: no federal status |
| White Tern (Also known as Fairy Tern), Manu-O-Ku, <u>Gygis alba rothschildi</u> : listed as threatened on Oahu, the extent of its known breeding range in the state | White tern: no status under ESA, protected by MBTA |
| (5) Under HAR Title 13, Part II, Chapter 24, the taking of any species of wild bird is prohibited unless permitted by DLNR | Only migratory bird species (including most seabirds) are protected by MBTA; no federal permit requirement applies to the taking of other species of wild birds not listed as endangered, threatened, or proposed for inclusion under ESA |

LIST OF POTENTIAL TO-BE-CONSIDERED (TBCs)

In addition to ARs, "to-be-considered" criteria (TBCs) may also impact remedial cleanups. "TBCs are non-promulgated advisories or guidance issued by federal or state agencies that are not legally binding and do not have the status of potential ARs.

Under certain circumstances, TBCs may be considered along with ARs as part of a site risk assessment and may be used in determining the necessary level of cleanup to be achieved for the protection of human health or the environment. Where no ARs or mechanism for determining cleanup levels exist for the cleanup of a particular contaminant or medium, TBCs may be used to dictate necessary cleanup endpoints. For this reason, TBCs developed by state programs may figure largely in the development of site specific cleanup criteria and should be thoroughly analyzed to determine their appropriateness.

The following is a list of potential TBCs identifying their cleanup goals as expressed in the form of chemical concentration levels or location- and action-specific strategies. This section also includes an overview of the Department of Agriculture's Pesticide Program and monitoring techniques which it is currently considering for possible inclusion in future guidelines.

DEPARTMENT OF HEALTH TBCs LIST

1. Solid and Hazardous Waste Branch, Underground Storage Tank Cleanup Goals (6 February, 1991)
2. Solid and Hazardous Waste Branch, Past Hazardous Waste Clean Closures Guidelines
3. Solid and Hazardous Waste Branch, Target Closure Cleanup Levels for Soil (Adopted from RCRA Facilities Investigation Guidance Document, 1989, as revised 10 May 1990)
4. Hazard Evaluation and Emergency Response Office, Recommended Soil Cleanup Levels for Dieldrin and PCBs
5. Environmental Planning Office, Hawaii Ground Water Quality Protection Strategy (12 March, 1990)
6. Technical Guidance Manual For Under Ground Storage Tank Closure and Release Response (August, 1992)

DEPARTMENT OF HEALTH CHEMICAL-SPECIFIC TBCs

DOH's Interim Recommended Cleanup Criteria for Soil and Water

| CONSTITUENT | Above UIC Line Drinking Water WATER (ppm) | Above UIC Line Drinking Water SOIL (ppm) | Below UIC Line Non-Drinking Water WATER (ppm) | Below UIC Line Non-Drinking Water SOIL (ppm) |
|---|---|---|---|--|
| Volatile Organic Compounds: | | | | |
| Benzene* | 0.005 | 0.05 | 1.7 | 1.7 |
| Ethylbenzene | 0.7 | 7.0 | 0.14 | 1.4 |
| Toluene | 1.0 | 10.0 | 2.1 | 21.0 |
| Semi-volatile and Nonvolatile Organic Compounds: | | | | |
| Benzo (a) pyrene* | 0.0002 | 1.01005001 | NS | 1.01005001 |
| Acenaphthene | NS | | 0.320 | |
| Fluoranthene | NS | | 0.013 | |
| Naphthalene | NS | | 0.78 | |
| Metals: | | | | |
| Lead (total) | 0.05 | 400 | 0.14, [0.0056]* | 400 |
| Cadmium (total) | 0.005 | 2.0 (natural background whichever is higher) | [0.0093] | 2.0 (or natural background whichever is higher) |
| Halogenated Organic Compounds: | | | | |
| Polychlorinated biphenyls* | 0.0005 | 1.0 | [0.00003] | 1.0 |
| 1,1,1 Trichloroethane | 0.2 | 2.0 | 10.4 | 10.4 |
| Tetrachloroethylene* | 0.005 | 0.05 | [0.145] | 0.145 |

* - Carcinogen; NS - No Standard; □ - Saltwater chronic surface water quality standard as established in Hawaii Administrative Rules (HAR), Title 11, Chapter 54; [□] - Currently proposed chronic standards in HAR 11-54 Revisions, April, 1992.

1. The recommended cleanup criteria for water at sites that are mauka of the UIC line are the existing or proposed MCL for that constituent. The recommended cleanup criteria for water at sites that are makai of the UIC line are based on the saltwater acute surface water quality standard (or chronic standard when available) as established in HAR Chapter 11-54.
2. The recommended cleanup criteria for volatile and halogenated organic compounds in soil at sites that are mauka of the UIC line are 10 times the existing or proposed MCL for that constituent with the exception of the criteria set for PCBs. The recommended cleanup criteria for PCBs in soil regardless of location are based on the required cleanup criteria for surface soils in non-restricted access areas as established under the Toxic Substances Control Act.
3. The recommended cleanup criteria for ethylbenzene and toluene in soil at sites that are makai of the UIC line is 10 times the saltwater acute surface water quality standards as established in HAR 11-54.
4. The recommended cleanup criteria for benzene, 1,1,1 TCA, and PCE in soil at sites that are makai of the UIC line are the same as the saltwater acute surface water quality standards (or chronic standards when available) as established in HAR 11-54 because of their degree of toxicity, pertinent physical and behavioral properties in the environment, and other health-related information.
5. The recommended cleanup criteria for semi-volatile and non-volatile organic compounds in soil regardless of their location relative to the UIC line are based on assessments of the physical and chemical characteristics of the compounds and the degradation, transformation, and toxicity of the constituents in the environment.
6. The recommended cleanup criteria for metals in soil regardless of their location relative to the UIC line are based on direct exposure to human and ecological receptors.
7. All sampling and analytical data intended to document or demonstrate that cleanup criteria (or other protective levels) have been attained should conform with appropriate field and laboratory quality assurance/quality control practices and should use appropriate methods for sample preparation, handling, and analysis.

DEPARTMENT OF HEALTH CHEMICAL-SPECIFIC TBCs (continued)

Solid and Hazardous Waste Branch Past Hazardous Waste Clean Closures Guidelines for Soil

| SITE | CONSTITUENT | SOIL CLEANUP GUIDELINES (ppm) | DATE APPROVED |
|-------------------------------------|-----------------|-------------------------------|---------------|
| Hawaii Independent Refineries, Inc. | Arsenic | 100.0 | 9/30/88 |
| | Cadmium | 9.0 | |
| | Lead | 500.0 | |
| | Phenanthrene | 20.0 | |
| | Pyrene | 20.0 | |
| Safety Kleen | Benzene | 5.0 | 11/25/91 |
| | TCLP Benzene | 0.5 | |
| | Ethylbenzene | 75.0 | |
| | PCBs (outdoors) | 10.0 | |
| | Toluene | 20.0 | |
| | TPH | 100.0 | |
| Chevron | Arsenic | 100.0 | 3/7/89 |
| | Cadmium | 10.0 | |
| | Lead | 500.0 | |
| | Phenanthrene | 20.0 | |
| | Pyrene | | |
| Pepper Industries | PCBs (indoor) | 10 μ g/100cm ² | 4/7/89 |
| | Lead (outdoor) | 500.0 | |

DEPARTMENT OF HEALTH CHEMICAL-SPECIFIC TBCs (continued)

Solid and Hazardous Waste Branch Target Closure Cleanup Levels for Soil (Adopted from RCRA Facilities Investigation Guidance Document, 1989 As Revised 5/10/90) (Based on 0.0004 ppm/day ingested of soil for risk analysis 10^{-6}).

| Constituent | Target Cleanup Level (ppm) |
|-------------------------|-----------------------------------|
| Chromium ^{III} | 80,000 (8%) |
| Chromium ^{IV} | 400 |
| Mercury | 24 |
| Methyl Naphthalenes | 20 |
| Naphthalene | 320 |
| Vanadium | 500 - 2,000 |
| Cobalt | 200 - 2,000 |
| Nickel | 100 |
| Barium | 4,000 |

DEPARTMENT OF HEALTH CHEMICAL-SPECIFIC TBCs (continued)

Hazard Evaluation and Emergency Response Office Recommended Soil Cleanup Levels for PCBs

PCBs The cleanup of polychlorinated biphenyls (PCBs) in Hawaii is guided by the Toxic Substances Control Act (TSCA) cleanup policy as defined in 40 CFR. However, if PCB contamination exists in a residential area where sensitive populations may be exposed, a more stringent guidance of 1.0 ppm is the recommended cleanup level for contaminated soil in lieu of a risk assessment.

DEPARTMENT OF HEALTH LOCATION-SPECIFIC TBCs

Environmental Planning Office & Safe Drinking Water Branch Hawaii Groundwater Quality Protection Strategy (12 March 1990)

The Hawaii Groundwater Quality Protection Strategy is one of seven subplans which comprise the Hawaii Water Quality Plan. The particular role of the Groundwater Quality Protection Strategy is to assess the State's groundwater resources and identify programs to conserve, augment and protect these resources. The goal of the Strategy is to protect human and sensitive ecosystems through the protection and enhancement of groundwater throughout the State. This goal will guide policy decisions with a determination that no avoidable pollution is "acceptable" established programs will be guided to protect the entire groundwater resource, not just the State's projected beneficial uses of the resource. Furthermore, an anti-degradation policy shall be employed to protect existing or future beneficial uses of groundwater. This policy shall be implemented by all regulatory programs in the Department of Health which have a potential impact on groundwater quality.

A differential management strategy will be used to implement the groundwater anti-degradation policy. Groundwater will be protected by restricting activities in areas where groundwater is vulnerable to contamination and by utilizing the best practicable control technology for activities that have a potential to pollute ground water. The key element of the differential management strategy for groundwater quality protection is "groundwater classification". Hawaii's groundwater classification is based on hydrology, geology, existing use, quality, replaceability, vulnerability to contamination, and ecological importance. Groundwater classification establishes the basis for a systematic approach to designation areas where aquifers need to be protected and restricting activities that constitute a probable threat of pollution to groundwater. While not a promulgated rule, this policy could have very significant implications for remedial actions carries out in close proximity to sensitive or threatened aquifers.

The Hawaii Groundwater Quality Protection Plan has also developed an Interim Groundwater Monitoring Strategy designed to determine the origin of groundwater contamination from discrete (point) sources of pollution. Under this interim strategy, the Environmental Planning Office began sampling for 39 target compounds (high-use pesticides and other chemicals) in 1987; the monitoring duties became the responsibility of the Safe Drinking Water Branch in September, 1989. In order to determine the compounds to be screened at each well in the state and develop a well-head protection program, the Environmental Planning Office contracted the Water Resources Research Center to classify aquifers using both UIC and Agricultural Use maps. To date, Oahu and Maui aquifers have been classified while Kauai, Hawaii, Molokai and Lanai will be classified in the near future. Once these maps are completed, the Department of Health will have a basis for setting boundaries around well-heads and requiring best management practices within those boundaries.

Within the larger context of the Hawaii Water Plan, the Commission on Water Resources Management under the Department of Land and Natural Resources, permits any use of groundwater or surface water and can designate an aquifer or an entire island as a Water Management Area (WMA). The WMA designation gives the State rather than the purveyors/counties, the authority to determine water use in that area and is meant to allow the state to be more protective of water resources. Currently, there are four WMAs in the State, all of which are on Oahu and based on groundwater needs. These as well as future WMAs could have significant impact on the cleanup of remedial sites within WMA boundaries.

DEPARTMENT OF AGRICULTURE PESTICIDE PROGRAM OVERVIEW AND PROPOSED MONITORING TECHNIQUES

Overview of Pesticides Program Authority and Pesticide Monitoring Techniques Currently Being Evaluated for Possible Inclusion in Future Guidelines (Based on 30 December, 1991, response to HEER Office statewide cleanup criteria questionnaire and 13 March, 1992, interview with Pesticides Program Manager, Robert A. Borsch)

Currently, the Department of Agriculture's Pesticides Program does not employ any ARs or TBCs more stringent than those implemented at the federal level which would pertain to the development of statewide cleanup criteria or the cleanup of future hazardous waste sites within the state.

Although the Department of Agriculture restricts the use of more pesticides through HAR 4-66-32 than the Environmental Protection Agency does through 40 CFR 152.175, these more stringent requirements pertain only to the legal application of pesticides, and not to the cleanup of contaminated sites. Rather, the cleanup of pesticides contaminated sites are conducted pursuant to the requirements of drinking water standards and worker protection standards. On the state level, the Department of Health's Safe Drinking Water MCLs are no more stringent than federal MCLs with the exemption of DBCP, EDB, and TCP. Similarly, the Department of Labor and Industrial Relation's Division of Occupational Safety and Health uses federally developed Time Weighted Averages and Permissible Exposure Limits as criteria to determine worker exposure to hazardous gases. Hazards from dermal exposure are assessed by using the pesticides label, which must be reviewed and approved by the Environmental Protection Agency, as an indicator of toxicity or sensitization. Because Hawaii relies exclusively on federally developed worker protection standards, and states are specifically prohibited by 7 USC Section 24(b) from using different packaging or labelling than the EPA, the state does not have any greater authority than EPA in addressing the cleanup of pesticide contaminated sites. (Although the Pesticides Program comments on cleanup protocols proposed by private parties within the state, it does not base its comments on any requirements or guidelines more stringent than those on the federal level, nor does it have the authority to approve or disapprove such cleanup protocols.)

While the drinking water MCLs for DBCP, EDB, and TCP are the only state ARs more stringent than federal regulations which would impact the cleanup of a pesticide contaminated site, the Pesticides Program, in consultation with the Hazard Evaluation and Emergency Response Office, can assess dermal hazards on a case-by-case basis or determine levels of concern for pesticide vapors or gases in a non-workplace situation. Currently, the two programs are investigating the ambient air levels to Telone (1,3-dichloropropene) in communities where the chemical has been applied. If investigations such as these indicate the need to be more protective than federal standards require for a particular pesticide, to-be-considered criteria may be developed in the future.

To date, there have been five pesticide contaminated sites in the state which required cleanup. Because all five sites were DBCP contaminated wells slated for residential use, cleanup was triggered by the state drinking water MCL for DBCP. With the use of carbon filtration systems, monitored by the Board of Water Supply, the presence of DBCP has dropped from 90 ppt to approximately 20 ppt (half the MCL).

To prevent future pesticide contamination of drinking water, the Pesticides Program is working with the Safe Drinking Water Branch and the Environmental Planning Office to develop a trend system to monitor the increasing or decreasing presence of pesticides in groundwater. As this system develops, it may clearly identify problem areas or compounds, and lead to the formulation of TBCs.

Modeling maps which predict the potential for leachability according to geographic location, precipitation and chemical characteristics of specific pesticides, are also being developed by the Pesticides Program to enhance groundwater protection strategies. However, the accuracy of this particular technique, which is being considered by states throughout the nation, has not proven to be entirely accurate and may require a great deal of fine tuning before it can be implemented as a viable decision making tool.

**DEPARTMENT OF HEALTH POTABLE WATER SYSTEMS TO-BE-CONSIDERED
MAXIMUM CONTAMINANT LEVELS FOR DRINKING WATER**

1. INORGANICS

| CONTAMINANTS | MAXIMUM CONTAMINANT LEVEL |
|--------------|---------------------------|
| Antimony | 6 µg/L |
| Beryllium | 4 µg/L |
| Copper | 1300 µg/L (Action Level) |
| Cyanide | 0.2 mg/L |
| Fluoride | 4 mg/L (2 Secondary) |
| Nickel | 100 µg/L |

2. CARBAMATES

| CONTAMINANTS | MAXIMUM CONTAMINANT LEVEL |
|--------------------|---------------------------|
| Aldicarb | 3 µg/L |
| Aldicarb Sulfone | 2 µg/L |
| Aldicarb Sulfoxide | 4 µg/L |
| Cargofuran | 40 µg/L |
| Oxamyl (Vydate) | 200 µg/L |

3. PESTICIDES/SYNTHETIC ORGANIC CHEMICALS

| CONTAMINANT | MAXIMUM CONTAMINANT LEVEL |
|-------------------------------|---------------------------|
| Benzo (a) pyrene | 0.2 µg/L |
| Di (2 - ethylhexyl) adipate | 400 µg/L |
| Di (2 - ethylhexyl) phthalate | 6 µg/L |
| Hexachlorobenzene | 1 µg/L |
| Hexachlorocyclopentadiene | 50 µg/L |
| Simazine | 4 µg/L |

**DEPARTMENT OF HEALTH POTABLE WATER SYSTEMS TO-BE-CONSIDERED
MAXIMUM CONTAMINANT LEVELS FOR DRINKING WATER (continued)**

4. HERBICIDES

| CONTAMINANTS | MAXIMUM CONTAMINANT LEVEL |
|--------------|---------------------------|
| Dalapon | 200 μ g/L |
| Dinoseb | 7 μ g/L |
| Picloram | 500 μ g/L |

5. OTHER MISCELLANEOUS

| CONTAMINANT | MAXIMUM CONTAMINANT LEVEL |
|----------------------------|---------------------------|
| 2,3,7,8 - TCDD | 30 pg/L |
| Glyphosate | 700 μ g/L |
| Endothall (rare in Hawaii) | 100 μ g/L |
| Diquat | 20 μ g/L |
| Silver | 0.1 mg/L (Secondary) |
| 1,2,4 - Trichlorobenzene | 5 μ g/L |
| Aluminum | 0.05 mg/L (Secondary) |

Appendix 5C

Risk Based Corrective Action and Decision Making at Sites

RISK-BASED CORRECTIVE ACTION AND DECISION MAKING AT SITES WITH
CONTAMINATED SOIL AND GROUNDWATER

VOLUME I

December 1995

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EXECUTIVE SUMMARY

This report presents and describes a refined, risk-based corrective action (RBCA) process that has been implemented by the Hawai'i Department of Health (DOH) for assessment and remediation of sites with contaminated soil and groundwater. Chapter 1 presents a revision of Tier 1, DOH-recommended ("default") action levels for soil and groundwater in accordance with advances made in quantitative direct-exposure and contaminant fate-and-transport models. To reflect their purpose to serve as a guide to site remedial actions but not necessarily to serve as strict "cleanup numbers", DOH has chosen to refer to the revised criteria as soil and groundwater "action" levels.

Tier 1 soil and groundwater action levels appropriate for a given site are chosen from a lookup table based on the location of the site with respect to potential impact on drinking-water resources and annual rainfall at the site. Soil and groundwater action levels for contaminants not listed in the report can be obtained from the DOH.

Groundwater action levels adhere to state and federal surface water and drinking water standards. As a minimum, groundwater action levels are set to be protective against potential adverse impact to surface water ecosystems. For sites where drinking water resources may also be impacted, groundwater action levels are refined as needed to additionally meet drinking water standards.

Soil action levels are set to be protective of direct, residential exposure to impacted soils and adverse groundwater impact due to remobilization (e.g., leaching) of contaminants from the soil. Soil action levels are generated with the aid of computer-assisted, risk-based, direct-exposure models and vadose-zone leaching models. Action levels are contaminant-specific and based on both the potential mobility and toxicity of the contaminant.

The Tier 1 soil action levels presented in the lookup table may be overly conservative for small areas of impacted soil (e.g., less than one-half acre). Chapter 2 provides guidelines for use of the models on a Tier 2, site-specific basis. In Tier 2 site assessments, DOH allows a controlled use of the Tier 1 models to generate more site-specific soil action levels without the need for a full-scale, time-consuming, and generally costly "risk assessment (Tier 3)." Site-specific factors that can be taken into account in Tier 2 assessments include the actual volume of impacted soil at the site and the geology and hydrogeology of the site. User-friendly computer spreadsheets are available from DOH for use in Tier 2 site evaluations. For further guidance on Tier 2 procedures refer Chapter 2 of this document. DOH should be consulted prior to a facility undertaking a full-scale (Tier 3) risk assessment.

CHAPTER 1

TIER 1 ACTION LEVELS FOR SOIL AND GROUNDWATER

INTRODUCTION

Revised Tier 1 soil and groundwater action levels are presented in Table 1-1. These criteria replace and take precedence over the criteria presented in the DOH "Technical Guidance Manual (TGM) for Underground Storage Tank Closure and Release Response (August, 1992)" (HIDOH, 1992). Tier 1 action levels applicable to a given site are determined with respect to two site characteristics (refer to Table 1-1):

1. Utility (drinking water or non-drinking water) of groundwater impacted or potentially impacted; and
2. Annual rainfall at the site (less than or greater than 200cm/year).

Groundwater action levels for sources of drinking water sources are based on state and/or federal maximum contaminant levels (MCLs) for drinking water (Table 2). Recommended actions levels for groundwater that is not a source of drinking water are taken from the state surface water standards unless otherwise noted (Hawai'i Administrative Rules Title 11, Chapter 54).

Tier 1 soil action levels were generated to address three coinciding concerns at impacted sites (refer also to notes at end of Table 1-1):

1. Potential adverse impact on groundwater due to leaching of residual contamination from impacted soil,
2. Potential adverse impact on groundwater due to remobilization of free-phase product in impacted soils, and
3. Potential threats to human health due to direct exposure to impacted soil.

The soil action levels (SALs) are considered very conservative and adequate for any impacted site unless otherwise directed by DOH.

The potential impact of leachate and free-phase product on groundwater was evaluated by use of SESOIL, a vadose-zone, contaminant-fate-and-transport computer application. Direct-exposure concerns were evaluated by a slightly modified use of quantitative, risk-based, deterministic models used by EPA Region IX for development of "Preliminary Remediation Goals (PRGs)" (USEPA, 1995). For relatively mobile contaminants (e.g., volatile and semi-volatile organic compounds), soil action levels were generated to address each of the three concerns and then compared. The most stringent of the three action levels generated was then chosen as the action level for that impacted-site scenario. For metals and other comparatively less mobile contaminants, only the direct-exposure pathway was taken into account to generate the soil action level. DOH may require additional TCLP soil analysis for less-mobile contaminants on a site-by-site basis.

Site investigations should be carried out in accordance with guidelines presented in the DOH "Technical Guidance Manual for Underground Storage Tank Closure and Release Response (TGM)" and subsequent updates (HIDOH, 1992, 1995a, 1995b, 1995c, 1995d). At all contaminant release sites, the extent of soil and groundwater impact should be delineated out to Tier 1 soil and groundwater action levels unless otherwise approved or directed by DOH. In cases where groundwater has been impacted by a release but groundwater contaminant levels do not exceed Tier 1 action levels, it may, however, be appropriate to investigate and assess impacted soil with respect to direct-exposure concerns only. (Item 3 above, refer to section 9 and to Appendix F, Table 3.)

BACKGROUND

Existing Criteria

Recommended soil and groundwater action levels employed by the DOH prior to this revision are presented in Section 5, Table 5-1 of the DOH TGM (Appendix A). As retained in this revision, groundwater action levels were based on state and federal standards for drinking water and surface water.

Soil criteria were developed to meet two major goals: 1) ensure that residual contamination in vadose zone media (soil, sediment, rock, etc.) does not create an unacceptable health risk for direct human exposure through inhalation, ingestion, and dermal contact and 2) ensure that leaching of residual contamination from the vadose zone does not lead to a negative impact on groundwater resources or on surface waters. For volatile organic compounds, soil cleanup criteria were determined by multiplying corresponding, drinking water or surface water standards by an "attenuation factor" of ten, modified after a common method employed by the U. S. Environmental Protection Agency (EPA) for disposal of contaminated media in hazardous waste landfills (refer to TGM section 5.5.2.3, Appendix A).

Since publication of the August, 1992, version of the DOH TGM numerous advances have been made in quantitative, risk-based assessment of direct exposure to contaminated soil and in the field of vadose-zone contaminant fate and transport modeling. The revised soil action levels presented in this report reflect these recent advances.

DOH Tiered Approach to Site Remediation

In the past, DOH has allowed to use of site-specific risk assessments as an alternative to using the conservative, generic soil and groundwater action levels presented in the TGM. DOH has expanded this tiered approach to include a conservative but more flexible and cost-efficient method of setting site-specific soil action (cleanup) levels - Tier 2. The overall concept of the tiered approach is detailed in the ASTM document entitled "Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM, 1994)." **Note that DOH has chosen not to use the example quantitative models presented in the ASTM document.**

In Tier 1, the subject of this chapter, a facility refers to conservative, default ("generic") soil action levels provided by the DOH that can be used at any impacted site. The action levels are generated by incorporating default, conservative impacted-site and exposure assumptions into standardized, quantitative groundwater-impact and direct-exposure models used by the DOH.

In Tier 2, a facility is permitted to substitute actual site data into the same Tier 1 models and evaluate groundwater protection and direct-exposure concerns on a limited, but more site-specific basis. Procedures for generating Tier 2 soil action levels are described in Chapter 2.

In Tier 3, a facility employs alternative groundwater-impact models, direct-exposure models, and/or input parameter assumptions to evaluate an impacted site and supports all input data with a thorough and rigorous risk assessment. Procedures that should be followed in the preparation of risk assessments are outlined in the August, 1992, TGM (HIDOH, 1992) and briefly reviewed at the end of Chapter 2.

Facilities where soil and groundwater contamination exceeds Tier 1 action levels are required to initiate followup "action," whether this be remediation or exposure prevention and management to default action levels (Tier 1), limited refinement of soil action levels to reflect more site-specific data (Tier 2), or full refinement of soil action levels based on a detailed, site-specific risk assessment (Tier 3). The exposure prevention and management option is outlined in the August, 1992, TGM (HIDOH, 1992).

OBJECTIVES

Groundwater Protection Objectives

The importance of Hawaii's groundwater and surface water resources cannot be overemphasized. Essentially 100% of Hawaii's drinking water comes from groundwater resources. The quality of the state's inland and coastal surface waters is intricately tied to the quality of the islands groundwater and likewise plays a crucial role in the ecological and, in turn, economic health of the state.

DOH groundwater protection criteria for common contaminants of concern are given in Table 1-2. Tier 1 (and Tier 2) groundwater action levels for any site must as a minimum meet surface water standards. Tier 1 action levels for groundwater at any release site must meet surface water standards. Action levels for groundwater that is a current or potential source of drinking water are based on state maximum contaminant levels (MCLs) for drinking water (HAR, 1994) unless otherwise noted. Surface water standards are used in place of drinking water standards where the surface water standards are more stringent. Action levels for groundwater that is not a current or potential source of drinking water are based on state acute (or chronic, where available) surface water standards (HAR, 1992) unless otherwise noted. Drinking water MCLs are substituted for surface water standards where data regarding the latter are not available (e.g., benzo(a)pyrene).

Tier 1 soil action levels are set to meet the following objectives for groundwater protection:

- 1) Water that infiltrates through the vadose zone and recharges a groundwater system that is potentially interconnected to an ecologically sensitive body of surface water must meet surface water standards (either marine or fresh water, whichever is the more stringent) at the point that it passes into the groundwater.
- 2) Water that infiltrates through the vadose zone and recharges an aquifer system that is a current or potential source of drinking water must meet both surface water and drinking water standards at the time it passes into the aquifer.
- 3) Due to the heightened threat of groundwater impact, residual contamination present in the vadose-zone should not exceed theoretical saturation levels for individual contaminants of concern. Theoretical saturation levels presented for common petroleum constituents (e.g., naphthalene) are intended to address potential mobilization of the free product mixture as a whole rather than mobilization of specific contaminants.

The delineation and utility of groundwater systems on the islands should be made in accordance with the DOH policy statement "Determination of Groundwater Utility at Leaking Underground Storage Tank Sites (HIDOH, 1995b)." For the purposes of Tier 1 (and Tier 2) site evaluations, DOH assumes that all leachate that infiltrates through the vadose zone will impact a groundwater system. It is further assumed that all groundwater systems are potentially interconnected to bodies of surface water (streams, rivers, lakes, marshes, coastal waters, etc.) and that all of these surface water bodies are ecologically important.

Direct-Exposure Protection Objectives

In addition to being protective of groundwater resources, Tier 1 soil action levels are set to be protective of residential exposure to impacted soils through inhalation, ingestion, and dermal absorption. With the exception of only a few compounds, most notably benzo(a)pyrene and PCBs, direct-exposure soil action levels generated are set to meet a one-in-a-million (10^{-6}) cancer risk for carcinogenic contaminants and a hazard quotient of "1" for non-carcinogenic contaminants. The use of alternative direct-exposure objectives and assumptions at a site must be justified and documented in a Tier 3 risk assessment that is submitted to DOH for review and approval.

SESOIL VADOSE-ZONE CONTAMINANT-FATE-AND-TRANSPORT MODELS

SESOIL Computer Application

The potential for residual contamination to be leached from vadose zone soils and carried downward into groundwater was modeled using the RiskPro SESOIL computer

application (General Sciences Corporation, 1993, Version 1.07). An overview of the SESOIL application is presented in "The New SESOIL User's Guide (August, 1994)" published by the Wisconsin Department of Natural Resources (Hetrick et al., 1994). Excerpts from the publication are provided in Appendix B. A sensitivity analysis of SESOIL conducted by the Wisconsin Department of Natural Resources (WDNR, 1993) is included in the appendix.

SESOIL is a relatively simple and very user-friendly vadose-zone, contaminant-fate-and-transport computer application. The application allows for a monthly resolution of contaminant flux into the groundwater. In actuality, contaminant levels in leachate as it passes into groundwater could exceed the target maximum concentration levels during some portion of the month and the monthly average still fall below these target objectives. Resolution on a monthly scale is, however, the current best-available technology and, given the numerous other uncertainties involved in determining site cleanup levels, DOH feels that evaluation of groundwater impact on a month-averaged scale is adequate.

Impacted-Site Scenario

The generic impacted-site scenario used in the Tier 1 SESOIL simulations is depicted in Figure 1 and described in Table 1-3. The rationale behind the parameter values chosen is discussed in Appendix C. A technical discussion regarding use of the SESOIL computer application to generate groundwater-protection soil action levels that address potential groundwater impact is provided in Appendix D. An example of a SESOIL output file is provided in Attachment 1 of Appendix D. Results of the SESOIL models that were used to generate the Tier 1 lookup table (Table 1-1) are given in Appendix F.

SESOIL simulations are relatively easy to set up and run. As described in Appendix D, however, proper interpretation of SESOIL output is not necessarily straight forward and there is ample room to draw misleading or erroneous conclusions. The user must thoroughly understand the relationship between the SESOIL model simulation and the desired soil leaching model scenario. Use of SESOIL to generate alternative soil action levels for Tier 2 purposes must follow the procedures outlined in appendices C and D unless otherwise approved or directed by DOH.

DIRECT-EXPOSURE MODELS

DOH uses a standardized set of quantitative, risk-based, deterministic models to generate direct-exposure soil action levels for Tier 1 purposes. Default input parameter values used to generate direct-exposure soil action levels for Tier 1 are noted in Table 1-4. The exposure scenario assumes long-term, residential exposure to impacted soil through ingestion, inhalation, and dermal absorption. Slightly modified versions of models used by EPA Region IX to develop their "Preliminary Remediation Goals (PRGs, USEPA, 1994b, 1995)" are used to generate direct-exposure action levels for Tier 1.

Equations used in the EPA models reflect guidance provided in the California EPA

document entitled "Preliminary Endangerment Guidance Manual, January, 1994" (CAEPA, 1994). A discussion of the models is provided in Appendix E. Results of the direct-exposure models used to generate the Tier 1 lookup table (Table 1-1) are given in Appendix F.

DEVELOPMENT AND USE OF TIER 1 LOOKUP TABLE

Development of Tier 1 Lookup Table

The Tier 1 lookup tables presented in Table 1-1 were generated by comparing soil action levels generated for groundwater leachate impact, contaminant soil saturation, and direct-exposure impact (see Appendix F) and choosing the action level that corresponded to the impact of most concern for that particular impacted-site scenario (i.e., the most stringent action level). Maximum-allowable soil action levels are set at either the action level for direct-exposure or the SESOIL-generated, theoretical soil saturation concentration of the contaminant, whichever is more stringent. The same process of comparing soil action levels for different pathways of concern is used to generate more site-specific, Tier 2 soil action levels.

Note that the relationship between soil action levels (SAL) generated for different target leachate concentrations (CI) in the same impacted-site scenario is linear:

$$(SAL_1/CI_1) = (SAL_2/CI_2).$$

Once one soil action level has been generated, derivation of other soil action levels for the same impacted-site scenario but different groundwater protection objectives is a simple matter of factoring the generated SAL by the ratio of the target leachate concentrations:

$$SAL_2 = SAL_1 \times (CI_2/CI_1).$$

This quick and easy procedure was used to generate the soil action levels for surface water protection concerns in the Tier 1 lookup table, where applicable. (e.g. Note that the ratio between benzene SALs for surface water-protection concerns and SALs for drinking water-protection concerns is consistently 340, or the ratio of the target leachate concentrations - 1.7mg/l divided by 0.005mg/l).

The minimum soil action level presented for benzene in Table 1-1 is 0.050mg/kg, unchanged from that given in the 1992 TGM. Adhering to the Tier 1 model scenario, however, soil action levels generated by SESOIL for impacted soils within ten meters of groundwater that is a source of drinking water were actually somewhat lower (0.005mg/kg to 0.029mg/kg, refer to Appendix F). Based on previous experience at contaminant impacted sites, however, DOH believes that the SESOIL-generated soil action levels for drinking water protection concerns are overly conservative and that the difference between the SESOIL-generated estimate and the action level currently in use is not significant enough to warrant lowering the soil action level for benzene. Note that

if the model parameters were slightly adjusted (rainfall, thickness of impacted layer, chemical data - especially the input benzene biodegradation rate, etc.), a soil action level of 0.050mg/kg could be easily attained.

General Application of Tier 1 Soil Action Levels

The Tier 1 SALs presented in Table 1 can be applied to sites where the zone of soil contamination is two meters thick or less and that the depth to groundwater from the base of the contaminated soil is greater than two meters. Additional modeling has suggested that the Tier 1 SALs for groundwater protection are adequately protective for sites where impacted soil is within two meters of groundwater as long as the thickness of impacted soil is one meter or less (refer to following section).

Table 1-1 is divided into release site scenarios based on the utility of groundwater impacted or potentially impacted and annual rainfall at the site. Table 1-1a presents action levels applicable to sites that threaten groundwater that is a source or potential source of drinking water. Table 1-1b presents actions levels for sites that do not threaten groundwater that is a source or potential source of drinking water. Each table is further subdivided into action levels for sites receive less than or greater than 200cm of rainfall annually. Rainfall maps for each of the islands are provided in Appendix G for reference to the location of impacted sites. For more detailed rainfall information contact the Department of Land and Natural Resources or the office overseeing investigation and remediation of the subject impacted site.

Initial comparison of the SESOIL application results with limited available field data suggests that the model overestimates groundwater impact by an order of magnitude or more. For sites where the base of the impacted soil is within a few meters of groundwater, it may be more prudent to investigate groundwater quality at the site rather than rely on theoretical models.

Application of SALs to Soils Two Meters or Less From Groundwater

As described, the Tier 1 soil action levels are based on the assumption that the depth to groundwater beneath the base of the impacted interval is greater than two meters and that the impacted soil is less than two meters thick. If the depth to groundwater from the base of the impacted interval is less than two meters at a site and the thickness of soil impacted is greater than two meters then DOH may require that a groundwater monitoring program be initiated in order to ensure that the Tier 1 soil action levels are adequately protective of groundwater.

Tier 2 Modification of SALs With Respect to Dilution of Leachate in Groundwater

The hydrogeologic nature of groundwater systems in Hawai'i is highly variable from site to site. Adhering to the intent of Tier 1 soil action levels to be conservative and applicable to any site, as well as a desire not to add an additional layer of uncertainty to groundwater-impact model, leachate dilution and degradation in groundwater is not

considered in the derivation of the Tier 1 soil action levels. In Tier 2, DOH allows for adjustment of the SESOIL-generated, Tier 1 soil action levels by use of a simple groundwater mixing model (refer to Chapter 2).

Application of Tier 1 Action Levels to Sites With Impacted Groundwater

At impacted sites where the main mass of contaminant has already reached and impacted groundwater, remediation of the impacted soils should be guided in part by actual groundwater monitoring. In some cases, a groundwater investigation may indicate that impacted soil is not adversely impacting groundwater even though SESOIL-generated soil action levels are exceeded (i.e., the theoretical SALs are too conservative). If this is the case, remediation of the impacted soil should be guided by direct-exposure concerns rather than groundwater-protection concerns. Conversely, a groundwater investigation may indicate that more stringent soil cleanup levels are warranted at the site (i.e., the theoretical SALs are not conservative enough). DOH anticipates that the latter case will be the exception rather than the rule.

Groundwater contamination in excess of Tier 1 action levels may not necessarily require active remediation. When groundwater contamination in excess of Tier 1 action levels is discovered at a site, the extent and magnitude of contamination should be determined. If continued monitoring and, where appropriate, through groundwater contaminant fate-and-transport modeling suggest that the plume of contaminated groundwater is not likely to migrate offsite and adversely impact groundwater extraction wells or surface water bodies then the contaminated groundwater can be left in place and allowed to degrade naturally over time. If this cannot be demonstrated then the contaminated groundwater should be actively remediated to Tier 1 action levels. Note that conclusions drawn from the results of contaminant fate-and-transport models must be supported by follow-up groundwater monitoring.

Unless otherwise approved or directed by DOH, downgradient monitoring of the plume can be discontinued when three successive seasonal cycles (generally three successive years) of groundwater monitoring indicate that the contaminated groundwater is not likely to migrate offsite and impact groundwater extraction wells or bodies of surface water at greater than Tier 1 action levels (i.e., the plume is stabilized). Monitoring of the body of groundwater that exceeds Tier 1 action levels should, however, be continued until contaminant levels drop below the action levels for two successive seasonal cycles. At this time DOH will issue a letter that no further investigative or remedial action is required at the site. Groundwater that is discharged from the site due to construction activities, etc., prior to this time must be tested for appropriate

contaminants and adhere to discharge requirements put forth by the DOH Clean Water Branch.

SUMMARY

Direct-exposure and vadose-zone, fate-and-transport models offer both regulatory agencies and facilities a valuable, scientifically-based tool to help set soil and groundwater action levels at impacted sites. As the "user friendliness" of computer applications increases, however, so does the tendency to use the applications as "black boxes" without proper evaluation of how the application actually manipulates input parameter values and the significance, if any, of the input data to the output file generated. Guidelines presented in this document should be adhered to unless otherwise directed or approved by DOH.

Theoretical soil action levels set to protect groundwater resources should not be considered absolute. A preliminary comparison of the SESOIL model results with actual field data suggests that the SESOIL-generated soil action levels are overly conservative. In some cases, particularly where groundwater has already been impacted, it may be more appropriate to initiate a groundwater monitoring program to help set soil action levels rather adhering to or relying on theoretically-derived action levels. DOH should be contacted for further guidance if a facility believes this may be the case at their site.

Figure 1. Geologic profile of generic model.

TABLE 1-1a. Tier 1 Action Levels for soil and groundwater: Rainfall
≤ 200cm/year

| RAINFALL ≤ 200CM/YEAR | | | | |
|---------------------------|-------------------------------------|------------------|---|------------------|
| Contaminant | DRINKING WATER SOURCE THREATENED | | DRINKING WATER SOURCE NOT THREATENED | |
| | Groundwater (mg/l) | Soil (mg/kg): | Groundwater (mg/l) | Soil (mg/kg): |
| Benzene | 0.005 | 0.05 | 1.7 | 1.7 |
| Toluene | 1.0 | 16 | 2.1 | 34 |
| Ethylbenzene | (0.14) | 0.50 | 0.14 | 0.50 |
| Xylene | 10 | 23 | [10] | 23 |
| Benzo(a)pyrene | 0.0002 | 1.0de | [0.0002] | 1.0de |
| Acenaphthene | (0.32) | 18sat | 0.32 | 18sat |
| Fluoranthene | (0.013) | 11sat | 0.013 | 11sat |
| Naphthalene | 0.24 | 41sat | 0.77 | 41sat |
| PCE | 0.005 | 0.29 | 0.145 | 5.0de |
| 1,1 DCE | 0.046 | 0.47de | 3.9 | 0.47de |
| Vinyl Chloride | 0.00002 | 0.18de | [0.00002] | 0.18de |
| TCE | 0.005 | 0.01 | 0.70 | 1.5 |
| 1,1,1 TCA | 0.20 | 0.10 | 6.0 | 3.0 |
| PCBs (all) | 0.0005 | 1de | 0.002 | 1de |
| Lead (total) | (0.0056) | 400de | 0.0056 | 400de |
| Cadmium (total) | 0.005 | 38de | 0.009 | 38de |
| TPH-residual fuels | NS | 5,000 | NS | 5,000 |
| TPH-middle distillates | NS | 5,000 | NS | 5,000 |
| TPH-gasolines | NS | 2,000 | NS | 2,000 |

TABLE 1-1b.Tier 1 Action Levels for soil and groundwater: Rainfall > 200cm/year

| RAINFALL > 200CM/YEAR | | | | |
|---------------------------|-------------------------------------|------------------|---|------------------|
| Contaminant | DRINKING WATER SOURCE THREATENED | | DRINKING WATER SOURCE NOT THREATENED | |
| | Groundwater (mg/l) | Soil (mg/kg): | Groundwater (mg/l) | Soil (mg/kg): |
| Benzene | 0.005 | 0.05 | 1.7 | 0.68 |
| Toluene | 1.0 | 2.6 | 2.1 | 5.5 |
| Ethylbenzene | (0.14) | 0.13 | 0.14 | 0.13 |
| Xylene | 10 | 8 | [10] | 8 |
| Benzo(a)pyrene | 0.0002 | 1.0de | [0.0002] | 1.0de |
| Acenaphthene | (0.32) | 18sat | 0.32 | 18sat |
| Fluoranthene | (0.013) | 11sat | 0.013 | 11sat |
| Naphthalene | 0.24 | 41sat | 0.77 | 41sat |
| PCE | 0.005 | 0.04 | 0.145 | 1.1 |
| 1,1 DCE | 0.046 | 0.47de | 3.9 | 0.47de |
| Vinyl Chloride | 0.00002 | 0.18de | [0.00002] | 0.18de |
| TCE | 0.005 | 0.004 | 0.70 | 0.56 |
| 1,1,1 TCA | 0.20 | 0.06 | 6.0 | 1.9 |
| PCBs (all) | 0.0005 | 1de | 0.002 | 1de |
| Lead (total) | (0.0056) | 400de | 0.0056 | 400de |
| Cadmium (total) | 0.005 | 38de | 0.009 | 38de |
| TPH-residual fuels | NS | 5,000 | NS | 5,000 |
| TPH-middle distillates | NS | 5,000 | NS | 5,000 |
| TPH-gasolines | NS | 2,000 | NS | 2,000 |

TABLE 1-1 (cont.). Tier 1 Action Levels for soil and groundwater: Notes

ANNOTATIONS:

unmarked criteria: groundwater-protection concerns dominate

de: direct-exposure concerns dominate

sat: saturation concentration, groundwater-protection concerns dominate

() Same as surface water; surface water standard more stringent than drinkingwater standard.

[] Same as drinking water; surface water standards not set.

PCE: tetrachloroethylene, DCE: dichloroethylene, TCE: trichloroethylene, TCA: trichloroethane,

PCBs: polychlorinated biphenyls, TPH: total petroleum hydrocarbons

NOTES:

1. Determination of groundwater utility should be determined based on the DOH policy *Determination of Groundwater Utility at Leaking Underground Storage Tank Sites* (September 13, 1995). (HIDOH, 1995b)
2. TPH criteria as presented in *Reporting, Remediation, and Management of Petroleum-Contaminated Soil* (December, 1995). (HIDOH, 1995d). Gasolines: characterized by a predominance of alkyl benzenes and straight-chain, branched, and cyclo- alkanes and alkenes with carbon ranges of C6 to C12. Middles distillates (e.g., kerosene, diesel fuel, home heating fuel, jet fuel, etc.): characterized by a predominance of straight-chain alkanes and polynuclear aromatic hydrocarbons with carbon ranges of C12 to C24. Residual fuels: characterized by long chain alkanes (carbon range > C24) and less predominant aromatics that include phenathrenes, benzopyrenes, and other poly-nuclear aromatic hydrocarbons.
3. The facility should contact DOH for further guidance when laboratory practical quantification limits exceed the recommended groundwater criteria.
4. Lowermost limit on soil action levels for benzene leachate concerns set at 0.05mg/kg based on field experience rather than adhering to SESOIL results. (See Chapter 1.)
5. Soil action levels set for leachate-impact concerns (SALs not annotated with "sat" or "de") assume depth to groundwater is two meters or less and assume no dilution of leachate in groundwater (i.e., Dilution Attenuation Factor (DAF) = 1. Not applicable to TPH criteria. See Chapter 2 and Table 1 in Appendix F.).
6. Refer to Tier 2 discussion (Chapter 2) for guidance on adjustment of Tier 1 leachate-impact SALs with respect to depth to groundwater from the base of the impacted soil and site-specific DAFs.

GROUNDWATER-IMPACT MODEL (see text)

Climate data: Standard rainfall models: 'Āhuimanu Loop station data adjusted to 200cm annual rainfall.

High rainfall models: Honomū Mauka station data adjusted to 400cm annual rainfall.

Geologic model: Sand or very permeable saprolite/soil overlying fractured, porous basalt.

DIRECT-EXPOSURE MODEL (see text)

Assumes long-term residential exposure to impacted soil through inhalation, ingestion, and dermal absorption.

TABLE 1-2. Tier 1 and Tier 2 groundwater protection standards

| Contaminant | ^{1,2} Current/Potential Drinking Water Resource (mg/l) | ^{1,3} Non-Drinking Water Resource (mg/l) |
|----------------|---|---|
| Benzene | 0.005 | 1.7 |
| Toluene | 1.0 | 2.1 |
| Ethylbenzene | (0.14) | 0.14 |
| Xylene | 10 | [10] |
| Benzo(a)pyrene | 0.0002 | [0.0002] |
| Acenaphthene | (0.32) | 0.32 |
| Fluoranthene | (0.013) | 0.013 |
| Naphthalene | ⁵ 0.24 | 0.77 |
| PCE | 0.005 | ⁴ 0.145 |
| 1,1 DCE | 0.046 | 3.9 |
| Vinyl Chloride | 0.00002 | [0.00002] |
| TCE | 0.005 | 0.70 |
| 1,1,1 TCA | 0.20 | 6.0 |
| Lead (total) | (0.0056) | ⁴ 0.0056 |
| Cadmium | 0.005 | ⁴ 0.0093 |
| PCBs | 0.0005 | ⁶ 0.002 |

- () Same as surface water; surface-water standard more stringent than drinking water standard.
- [] Same as drinking water; surface-water standards not set.
- 1. Groundwater utility as defined by DOH (refer to HDOH, 1995b).
- 2. Drinking water MCL for contaminant unless otherwise noted (HAR Chapter 11-20, 1994).
- 3. Surface water acute standard (or chronic standard where available and applicable) for contaminant unless otherwise noted (HAR Chapter 11-54, 1992).
- 4. Marine chronic surface water quality standard as established in HAR, HAR 11-54.
- 5. Drinking water criteria provided in USEPA Region IX Preliminary Remediation Goals document (USEPA, 1995).
- 6. Ecology-based, freshwater acute standard used for PCBs. (Freshwater and chronic standards are based on FDA action levels for PCBs in fish for commercial consumption rather than ecological impact and were not used in this study.).

TABLE 1-3. Site parameters and default values used in Tier 1 SESOIL models

| | | | |
|---|------------------|---|----------------------------------|
| <u>Climate Data:</u> | | | |
| Air Temperature: | | 25°C | (all months) |
| Evapotranspiration (cm/day): | | 40% | of rainfall |
| Precipitation (cm/month): | | 200 or 400cm/year, | month-specific |
| Storm Duration (days) | | month-specific | |
| Number of Storms: | | month-specific | |
| Days per Month: | | 30.4 | (default, all months) |
| <u>Soil Properties:</u> | | | |
| Bulk Density (g/cm ³): | | 1.5 | (all layers) |
| Intrinsic Permeability (cm ²): | | 0 | (specified in soil column input) |
| Disconnectedness Index: | | 3.5 | (all layers) |
| Effective Porosity: | | 0.3 | (all layers) |
| Organic Carbon Content (%): | | 0.1 | (layer specific) |
| Cation Exchange Capacity (meq/100g): | | 0 | (all layers) |
| Freundlich Equation Exponent: | | 1.0 | (all layers) |
| <u>Application Data:</u> | | | |
| Number of years of input data: | | 25 | |
| Number of geologic column layers: | | 4 | |
| Application area: | | 1,000cm ² | |
| Spill mode: | | Instantaneous | |
| Pollutant input mode: | | Concentration (ug/g) | |
| Washload Simulation: | | not used | |
| <u>Soil Column Properties:</u> | | | |
| <u>Layer #</u> | <u>Thickness</u> | <u>Permeability</u> | <u>¹OC Content</u> |
| 1 (soil) | 200cm | 1E-07cm ² | same as input |
| 2 (soil) | 100cm | 1E-07cm ² | 1.0 |
| 3 (basalt) | 400cm | 1E-06cm ² | 0.001 |
| 4 (basalt) | 1cm | 1E-06cm ² | 0.001 |
| 1. Foc as a fraction of the input soil property value | | | |
| <u>Pollutant Loading Data (Layer 1 only)</u> | | | |
| 1st year, 1st month | | Input concentration (ug/g) calibrated to specific contaminant & model | |
| Load for all other months | | 0 ug/g | |
| Volatilization (fraction) | | 0.2 (all months) | |

TABLE 1-4. Exposure parameters and default values used in Tier 1 direct-exposure models

| Human Receptor Data | Default |
|--|---------|
| 25% surface area - adults (cm ²) | 5000 |
| 25% surface area - children (cm ²) | 2000 |
| Adherence factor (unitless) | 0.2 |
| Inhalation Rate - adults (m ³ /d) | 20 |
| Inhalation Rate - children (m ³ /d) | 10 |
| Soil ingestion rate - adults (mg/d) | 100 |
| Soil ingestion rate - children (mg/d) | 200 |
| Exposure time - residents (h/d) | 24 |
| Exposure frequency - residents (d/y) | 350 |
| Exposure duration - residents total (yrs) | 30 |
| Exposure duration - children (yrs) | 6 |
| Body weight - adult (kg) | 70 |
| Body weight - child (kg) | 15 |
| Averaging time (yrs) | 70 |
| Other variables | |
| Diffusion height (m) | 2 |

CHAPTER 2

TIER 2, SITE-SPECIFIC EVALUATION OF IMPACTED SOILS

INTRODUCTION

Tier 1 (default, generic), contaminant-specific action levels for impacted soil are set to be protective of both groundwater resources and human health (Chapter 1). As an alternative to use of the conservative, generic, Tier 1 soil action levels (SALs) at a given site, this chapter presents guidelines for the generation of more site-specific, "Tier 2" soil action levels that incorporate actual site characteristics into the same models used to generate the Tier 1 SALs. The results of an example, Tier 2 assessment are given in Table 2-1. Lookup tables and spreadsheet models used to generate the example Tier 2 SALs and additional Tier 2 examples are discussed later in the chapter.

Among other site characteristics, the Tier 2 models allow facilities to take into account the actual volume of contaminated soil at the site, the depth to groundwater and the expected dilution of contaminant leachate as it passes into groundwater. Corresponding site-specific data that may be incorporated into the Tier 2 models include the areal extent of contamination, the thickness of the impacted soil interval, the depth to groundwater from the base of the impacted soil, the regional groundwater gradient and the annual rainfall at the site.

Site-specific, Tier 2 assessment of groundwater contamination should adhere to groundwater criteria presented in Table 2-2. Site-specific assessment of soil contamination should address the following concerns:

1. Potential adverse impact on groundwater due to leaching of residual contamination from impacted soil,
2. Potential adverse impact on groundwater due to remobilization of free-phase product in impacted soils, and
3. Potential threats to human health due to direct exposure to impacted soil.

Tier 2 SALs generated for groundwater-protection concerns and direct-exposure concerns should be compared and the most stringent SAL should be applied to the site.

Tier 2 soil action levels can be generated by use of one or more of four DOH-approved computer models and spreadsheets:

1. SESOIL (General Sciences Corporation, version 1.07 and later updates) - used to address leachate impact on groundwater and potential mobilization of free product from impacted soil;
2. QUIKSOIL (DOH spreadsheet) - used as a quick but simplistic and conservative alternative to SESOIL to address leachate impact on groundwater; (Not recommended for highly volatile or biodegradable contaminants or for sites

where the base of the impacted soil is greater than ten meters from groundwater.);

3. DAF (DOH spreadsheet) - used to approximate a site-specific dilution attenuation factor (DAF) that reflects the dilution of leachate it mixes with groundwater. Tier 1 or Tier 2 SALs generated with SESOIL or Tier 2 SALs generated with QUIKSOIL should be multiplied by the site DAF to refine final SALs for groundwater-protection concerns.
4. DETIER2 (DOH spreadsheet) - used to evaluate potential impact on human health from direct-exposure to impacted soil.

The groundwater-protection models are especially applicable to sites impacted with relatively mobile organic contaminants. The SESOIL computer application is available from the noted distributor. The QUIKSOIL, DAF, and DETIER2 spreadsheets are available from the DOH Solid and Hazardous Waste Branch. SESOIL models normally take ten to thirty minutes to complete once the operator has collected the necessary input data and has become familiar with the application. Use of the application must adhere to procedures presented in this chapter unless otherwise approved or directed by DOH. Spreadsheet calculations take only a matter of minutes.

Site investigations should be carried out in accordance with guidelines presented in the DOH "Technical Guidance Manual for Underground Storage Tank Closure and Release Response (TGM)" and subsequent updates (HIDOH, 1992, 1995a, 1995b, 1995c, 1995d). At all contaminant release sites, the extent of soil and groundwater impact should be delineated out to Tier 1 soil and groundwater action levels unless otherwise approved or directed by DOH. In cases where groundwater has been impacted by a release but groundwater contaminant levels do not exceed Tier 1 action levels, it may, however, be appropriate to investigate and assess impacted soil with respect to direct-exposure concerns only. (Refer to section 9 and to Appendix F, Table 3.)

Facilities are encouraged to use the Tier 2 models to address site-specific remediation needs rather than rely on the Tier 1 lookup tables or before undertaking a more costly and time consuming "Tier 3" site evaluation. Facilities should be aware, however, that re-use and disposal of impacted soil left in place at a site may fall under regulation by the DOH Office of Solid Waste Management should that soil ever be excavated, regardless of whether the soil meets Tier 1, 2, or 3 criteria for groundwater-protection and direct-exposure concerns (refer to HIDOH, 1995d).

Section 2 and 3 of this chapter reviews DOH's tiered approach for setting appropriate soil and groundwater action levels at a site and discusses groundwater-protection and direct-exposure objectives. Sections 4, 5, 6, and 8 present models for generation of Tier 2 SALs for groundwater-protection concerns. Section 7 presents a model for generation of Tier 2 SALs for direct-exposure concerns. Section 9 summarizes the procedure for choosing the appropriate SAL for a site and provides results from four example sites. Readers are encouraged to briefly review the example results (Appendix I) before moving

on to the main text of this chapter.

Section 10 provides additional guidance for sites where groundwater has already been impacted by a vadose-zone release. The final section of the chapter briefly reviews the intent of Tier 3 risk assessments and introduces a Tier 3, direct-exposure spreadsheet (DETIER3) available from DOH for public use. Note that for use in this report, the term "soil" refers to any unlithified, subsurface, solid media.

DOH TIERED APPROACH TO SITE EVALUATIONS AND REMEDIAL ACTIONS

In the past, DOH has allowed the use of site-specific risk assessments ("Tier 3") as an alternative to use of default, generally conservative, soil and groundwater action levels ("Tier 1"). The high costs and general lengthy review time typical associated with formal risk assessments, however, made the use of this option prohibitive at all but the largest release sites or sites where potential remedial costs outweighed risk assessment costs.

In response to this dilemma, DOH has refined its tiered approach to site remedial actions to include a conservative but more flexible and cost-efficient method of setting site-specific soil action levels - Tier 2. The overall concept of the tiered approach to site evaluations is detailed in the ASTM document entitled "Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM, 1994)." (Note that DOH has chosen not to use the example quantitative models presented in the ASTM document.)

In Tier 1, a facility refers to conservative, default ("generic") soil action levels provided by the DOH that can be used at any impacted site (refer to Chapter 1). The Tier 1 action levels were generated by incorporating default, conservative impacted-site and exposure assumptions into standardized, quantitative groundwater-protection and direct-exposure models used by the DOH.

In Tier 2, the subject of this chapter, a facility is permitted to substitute actual site data into the same models used to generate Tier 1 SALs as well as additional, DOH-approved models and evaluate groundwater-protection and direct-exposure concerns on a controlled, but more site-specific basis.

In Tier 3, a facility employs alternative groundwater-impact models, direct-exposure models, and/or input parameter assumptions to evaluate an impacted site and supports all input data with a thorough and rigorous risk assessment. Procedures that should be followed for the preparation of Tier 3 risk assessments are briefly outlined at the end of this chapter and more fully discussed in DOH technical guidance manuals (HIDOH, 1992).

Impacted sites with contaminant concentrations in excess Tier 1 soil or groundwater

assessment (Tier 3).

TIER 2 SOIL ACTION LEVEL - OBJECTIVES

Groundwater Protection Objectives

The importance of Hawaii's groundwater and surface water resources cannot be overemphasized. Essentially 100% Hawaii's drinking water comes from groundwater resources. The quality of the state's inland and coastal surface waters is intricately tied to the quality of the islands groundwater and likewise plays a crucial role in the ecological and, in turn, economic health of the state.

Tier 2 soil action levels for groundwater-protection concerns must be set to meet the following objectives:

- 1) Leachate that infiltrates through the vadose zone and recharges any groundwater system must not cause the groundwater to be impacted at greater than DOH standards for surface water (either marine or fresh water, whichever is the more stringent).
- 2) Leachate that infiltrates through the vadose zone and recharges a groundwater system that is a current or potential source of drinking water must not lead to a groundwater impact that exceeds either surface water or drinking water standards.
- 3) Due to the heightened threat of groundwater impact, residual contamination present in the vadose-zone should not exceed Tier 1, theoretical saturation levels for individual contaminants of concern.

The delineation and utility of groundwater systems on the islands should be made in accordance with the DOH policy statement "Determination of Groundwater Utility at Leaking Underground Storage Tank Sites (HIDOH, 1995b)." For the purposes of both Tier 1 and Tier 2 site evaluations, DOH assumes that all leachate that infiltrates through the vadose zone will impact a groundwater system. It is further assumed that all groundwater systems are potentially interconnected to bodies of surface water (streams, rivers, lakes, marshes, coastal waters, etc.) and that all of these surface water bodies are ecologically important.

DOH groundwater protection criteria for common contaminants of concern are repeated in Table 2-2. Tier 1 and Tier 2 groundwater action levels for any site must meet at least surface water standards. Tier 2 action levels for groundwater at any release site must meet surface water standards. Action levels for groundwater that is a current or potential source of drinking water are based on state maximum contaminant levels (MCLs) for drinking water (HAR, 1994) unless otherwise noted. Surface water standards are used in place of drinking water standards where the surface water standards are more stringent. Action levels for groundwater that is not a current or

potential source of drinking water are based on state acute (or chronic, where available) surface water standards (HAR, 1992) unless otherwise noted. Drinking water MCLs are substituted for surface water standards where data regarding the latter are not available (e.g., benzo(a)pyrene).

Direct-Exposure Objectives

In addition to addressing groundwater protection concerns, Tier 2 SALs ultimately applied to a site must be also be protective of residential exposure to impacted soils through inhalation, ingestion, and dermal absorption. With the exception of only a few compounds, most notably benzo(a)pyrene and PCBs, direct-exposure soil action levels generated are set to meet a one-in-a-million (10^{-6}) cancer risk for carcinogenic contaminants and a hazard quotient of "1" for non-carcinogenic contaminants. The use of alternative direct-exposure objectives and assumptions at a site must be justified and documented in a Tier 3 risk assessment that is submitted to DOH for review and approval.

GENERATION OF TIER 2 SALs FOR GROUNDWATER-PROTECTION CONCERNS - SESOIL APPLICATION

SESOIL Computer Application

RiskPro's SESOIL vadose-zone contaminant fate and transport computer application (GSC, 1993, Version 1.07) developed by General Sciences Corporation (GSC) or updates to the application must be used for Tier 2 evaluations of potential groundwater impact unless otherwise approved or directed by DOH. An overview of the RiskPro SESOIL application is presented in "The New SESOIL User's Guide (August, 1994)" published by the Wisconsin Department of Natural Resources (Hetrick et al., 1994). Excerpts from the publication are provided in Appendix B. A sensitivity analysis of SESOIL conducted by the Wisconsin Department of Natural Resources (WDNR, 1993) is included in the appendix.

Other versions of the SESOIL application may be inappropriate for use in either Tier 2 or Tier 3 site evaluations. An example of unacceptable versions of SESOIL include the SESOIL module in the 1995 "Decision Support Software" computer application put forth by the American Petroleum Institute (API, 1994). Output from this version of SESOIL provides only a yearly resolution of groundwater impact, rather than monthly as in the original version of the application.

A table of SESOIL-generated SALs based on the default Tier 1 site scenario are presented in Appendix F for variable depths to groundwater. As an alternative to re-running SESOIL models at sites where depth to groundwater may be an important factor in setting groundwater protection SALs, facilities can refer to SALs presented in Appendix F for use in Tier 2 assessments. The default SALs should be multiplied by the appropriate site dilution attenuation factor, as described below, in order to generate a final groundwater protection SAL for the site.

Unless otherwise approved or directed by DOH, use of SESOIL to generate soil action levels for Tier 2 (or Tier 3) purposes must follow assumptions and procedures described in this chapter. Note that for Tier 3 site evaluations, any vadose-zone application can be used provided that the application generates at least a monthly resolution for groundwater impact. If the model results are not as conservative as would have been produced using the GSC version of SESOIL, however, then the discrepancy should be discussed and justified in the Tier 3 report and use of the application approved by DOH.

SESOIL Model Procedures

Procedures regarding use of SESOIL to generate initial Tier 2 SALs are described below. Each step corresponds to an input module of the application. Fill out and submit the SESOIL worksheet provided in Appendix D (attachment D2) for each mode run. A summary of the input data parameters and default values used in the Tier 1 models is provided in Table 2-3. A complete description and discussion of the Tier 1 default parameter values is provided in Appendix C.

Step 1: Input Model Simulation Information

Note the site name, DOH ID number, and contaminant modeled in the module heading. "Raingage station" refers to the source of climate data used in the simulation. The number of years of climate data input will normally be "1" (climate data is repeated in subsequent model simulation years). The model simulation time will vary based on the physio-chemical nature of the contaminant and the hydrogeology of the site. (Due to memory limitations, the IBM 466DX used for Tier 1 could not run SESOIL simulations greater than 25 years in length.)

Step 2: Input Climate Data

Input data from the most correlative climate station (an optional climate data set is available with the RiskPro SESOIL application). Evapotranspiration can be directly calculated from input cloud cover, humidity, and albedo data. For most climate stations, however, these data are not available. If this is the case, input a value of "0" for monthly cloud cover, humidity, and albedo data and input evapotranspiration as a fraction of total rainfall based on the island location of the site as follows (data from Atlas of Hawai'i, 1983): Ni'ihau: 72% total rainfall, Kaua'i: 24% total rainfall, O'ahu: 36% total rainfall, Moloka'i: 54% total rainfall, Maui: 27% total rainfall, Lāna'i: 66% total rainfall, Kaho'olawe: 70% total rainfall, and Hawai'i: 44% total rainfall. Note that evapotranspiration data must be input as cm/day.

Where appropriate climate data are not available, determine the annual rainfall for the site based on maps provided in Appendix G. Refer to the default climate data provided in Table 2-4 and modify the default monthly precipitation (total 200cm/year) to reflect actual annual rainfall determined for the site (e.g., for sites with 100cm of annual rainfall the default precipitation data would be multiplied by a factor of 0.5). Input evapotranspiration as the appropriate, daily fraction of total rainfall based on the island

that the site is located on (see above).

Step 3: Input Soil Property Data

Input site-specific soil property data where supported by information gained during the site investigation or related published reports. Otherwise, use the default, Tier 1 parameter values noted in Table 2-3. For sites where mixtures of contaminants are present (e.g., petroleum releases), assume that an organic carbon content of no more than 0.1% is available for sorption of any given contaminant.

The data input into the soil property module are applied to the uppermost layer of the geologic model and then used as default values for subsequent layers. Input a value of "0" for the default soil permeability. Layer-specific permeability will be set in the "Soil Column Properties" module (step 6).

The default soil property data presented in Table 2-3 are based on information published by the U.S. Department of Agriculture (Foote et al., 1972; USDOA, 1976; USDOA, 1992) and the University of Hawai'i - Mānoa Water Resources Research Center (Miller et al., 1988; Mink and Lau, 1990), and also on discussions with local experts of Hawai'i's soils and hydrogeology (Table 2-5). Refer to the discussion in Appendix C and the DOH Tier 1 document for additional discussion regarding soil and bedrock properties in Hawai'i.

Step 4: Input Physio-Chemical Constants for Contaminant

Default physio-chemical constants and biodegradation rates for common contaminants are provided in tables 2-6 and 2-7. These constants should be used for both the SESOIL and direct-exposure models unless otherwise approved or directed by DOH. Contact the DOH Solid and Hazardous Waste Branch for information regarding contaminants not listed in the table. A value of "0" will normally be input for the hydrolysis and complexation constants noted in the module. Refer to Appendix C for a discussion on the source and justification of the default physio-chemical constants and biodegradation rates provided. Input physio-chemical constants can be supplemented with site-specific soil data where available (e.g., soil batch tests, etc.).

Step 5: Input Application Data

Input a value of "25" for the number of years of model simulation data. This should be sufficient for most model simulations. The number of soil layers input is governed by the geologic profile determined for the site. **Include a 1cm- thick layer at the base of the column and input the same soil/bedrock properties as the layer overlying it.** In the model simulation, this 1cm-thick layer directly overlies groundwater. Inclusion of a thin, basal layer is used to improve the precision of the SESOIL output data regarding the mass of contaminant moving from the vadose-zone into the groundwater (used in step 7).

The input application area reflects the areal extent of impacted soil and is used in

conjunction with layer thickness to calculate contaminant mass. SESOIL automatically generates the site latitude based on the input climate station. The spill mode should be set to "Instantaneous" to reflect the one-time presence of residual contamination in the model impacted layer (i.e., no continuous source). "Pollutant Load" should be set to "Concentration" to reflect soil contaminant concentration as input in the next module. Washload simulations are not applicable for Tier 2 models.

Step 6: Input Soil Column Properties

Input thickness and permeability data for each geologic layer. Refer to the default permeability data provided in Table 2-5 where site-specific data are not available. The number of soil sublayers will normally be set to one.

For the layers underlying the uppermost unit, input a value of "1" for all soil-property, factoring parameters except organic carbon (OC). For organic carbon, input factors that reflect site-specific data where available. For sites where site-specific OC data are not available, assume an organic carbon content of 0.0001% for all lithified (rock) units and for all sediment and soil layers situated at greater than 3 meters depth (following assumptions used in Tier 1) and adjust the input OC factor values accordingly. For sites where mixtures of contaminants are present (e.g., petroleum), assume a maximum of 0.1% OC for soils within three meters of the surface and 0.0001% OC for all lithified units and for all layers situated at greater than 3 meters depth.

Step 7: Input Pollutant Loading Data

Input a value of "0" for the first data-input year of the "mass transformed", "sink", and "ligand" columns unless otherwise approved or directed by DOH. The input factor will be repeated for all subsequent years of data. **Input a value of "0.2" for "volatilization factor" to limit contaminant loss due to volatilization to 20% of the maximum possible (required).** Note that unlike the factors noted above the volatilization factor must be repeated for every simulation year. (Click on the column heading and use the column math function to expedite data input.) The application erroneously assumes a volatilization factor of 1 for all months where no data is input.

Input a value of "0" for the monthly pollutant load of each year of input data (i.e., the number of data-input years noted in Step 5) except the first month of the first year. Following the procedures outlined in Appendix D, adjust the input soil concentration for the 1st year, 1st month until the model is calibrated to target groundwater-protection objective. **(Do not include assumed dilution of leachate at this point!)**

Step 8: Extract Groundwater-Impact SAL from Output Data.

Extract the SESOIL-generated SAL from the calibrated output file by following the procedures outlined in Appendix D. Change the SAL units to mg/kg. The final, site SAL for groundwater-protection concerns will be calculated by multiplying the SESOIL-generated SAL by the dilution attenuation factor determined for the site, as discussed

below.

Unedited (except for format) output files for SESOIL model simulations must be included with the report documenting the derivation of each Tier 2 soil action level. The version of SESOIL used to generate the Tier 2 soil action levels must be clearly indicated in the report. Warning messages in the output file regarding input rainfall and permeability data are based on the input of extremely variable data and are intended to prompt the user to recheck the input data modules. If the input data is correct then the warnings can generally be ignored.

GENERATION OF TIER 2 SALs FOR GROUNDWATER-PROTECTION CONCERNS - QUIKSOIL SPREADSHEET

The QUIKSOIL spreadsheet model is based on a simple contaminant partitioning equation that approximates the dissolved-phase ("leachate") concentration of the contaminant in impacted soil based on the physio-chemical nature of the contaminant and the soil. The model is based on an equation presented in ASTM's "Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (Table X2.1, ASTM, 1994)" for calculation of soil leaching factors:

$$SAL = C_w \times (Kd + (\theta_w + (\theta_a \times H'))/\rho_b),$$

where C_w is the target groundwater action level for the site (mg/L), Kd is the soil-water partition coefficient (L/Kg), θ_w and θ_a are the water- and air-filled porosities, H' is the Henry's law constant (unitless) and ρ_b is the soil bulk density.

Procedures regarding use of the QUIKSOIL spreadsheet to generate Tier 2 SALs are as follows:

- Step 1. Check with the DOH Solid and Hazardous Waste Branch to ensure that the spreadsheet you have is the most up-to-date version.
- Step 2. Input physio-chemical constants for the contaminant being evaluated. Constants for common contaminants are provided at the end of the spreadsheet (use "cut & paste" function of spreadsheet; refer also to Table 2-6). Contact the DOH Solid and Hazardous Waste Branch to obtain constants for contaminants not listed.
- Step 3. Input site data where available. (Model will use default, conservative parameter values where site data is not available.)
- Step 4. Input the target groundwater standard for the site (refer to Table 2-2). Do not include assumptions regarding dilution of leachate. Contact the DOH Solid and Hazardous Waste Branch to obtain groundwater criteria for contaminants not listed in Table 2-2.

- Step 5. Spreadsheet generates the contaminants Tier 2 SAL for groundwater-protection concerns at the site. Complete the information at the end of the first page of the spreadsheet. Include a copy of the spreadsheet for each contaminant modeled with the Tier 2 report submitted to DOH for review and approval.

An example printout of the QUIKSOIL spreadsheet is provided in Appendix H.

Users of the QUIKSOIL spreadsheet should be aware that the model does not incorporate DOH-acceptable assumptions regarding the fate and transport of the "leachate" in the vadose zone. With respect to the more comprehensive SESOIL application, the QUIKSOIL spreadsheet generates overly conservative SALs for contaminants that are highly biodegradable (e.g., half-life < 50 days) or highly volatile (e.g., Henry's Law constant > 0.01atm-m³/mol) or sites where the base of the impacted soil is situated greater than ten meters from groundwater. For contaminants or sites with these attributes, DOH strongly encourages use of the SESOIL application to generate groundwater-protection SALs.

CALCULATION OF FINAL SALs FOR GROUNDWATER-PROTECTION CONCERNS

SALs generated with SESOIL (either Tier 1 SESOIL SALs provided in Appendix F or Tier 2, site-specific SESOIL SALs) or QUIKSOIL should be further refined on a site-specific basis to account for dilution of leachate as it mixes with groundwater. Because the relationship between leachate concentration and soil concentration is assumed to be linear (i.e., Freundlich number in SESOIL application set to "1"), refinement of a SESOIL- or QUIKSOIL-generated SAL is a simple matter of multiplying the SAL by a leachate dilution attenuation factor (DAF) calculated for the site.

Site-specific dilution attenuation factors are generated using the DOH spreadsheet entitled "DAF" (refer to example in Appendix I). The DAF equation relates the volume of recharge water infiltrating into groundwater beneath a site during a year to the volume of impacted groundwater passing beneath the site during that year as follows:

$$DAF = 1 + ((V_s \times d_m) \times n_{eff}) / (I \times L),$$

where "V_s" (meters/year) is groundwater seepage velocity, "D_m" (meters) is the mixing depth of the leachate in groundwater, "n_{eff}" (m³/m³) is the fraction effective porosity, "I" (meters/year) is infiltration rate, and "L" (meters) is source length parallel to groundwater flow.

Annual groundwater recharge is reported in the yearly summaries of SESOIL output files. If Tier 1, SESOIL-generated SALs or SALs based on the QUIKSOIL spreadsheet are used for the site then groundwater recharge can be estimated as an island-specific fraction of total annual rainfall. Assume the following recharge with respect to the location of the site (data from Atlas of Hawai'i, 1983): Ni'ihau: 5% total rainfall, Kaua'i: 16% total rainfall, O'ahu: 36% total rainfall, Moloka'i: 16% total rainfall, Maui: 30% total rainfall, Lāna'i: 12% total rainfall, Kaho'olawe: 10% total rainfall, and Hawai'i: 31% total rainfall.

The spreadsheet calculates groundwater velocity (seepage) as:

$$V_s = (K \times h)/n_{eff}$$

where "K" is the hydraulic conductivity of the groundwater bearing media in meters per year, "h" is the hydraulic gradient.

Mixing zone depth is calculated by relating source length parallel to groundwater flow, aquifer thickness (d_a , meters), and the hydraulic conductivity of the groundwater-bearing media as follows:

$$d_m = (0.0112 \times L^2)^{0.5} + d_a(1 - \exp[(-L \times I)/(K \times h \times d_a)]).$$

The dilution factor equation presented above is used in ASTM's "Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites" (Table X2.1, ASTM, 1994). The mixing-zone depth equation is based on an equation published in EPA's *Technical Background Document for Soil Screening Guidance* (USEPA, 1994d).

Mixing-zone depths calculated using the equation will typically range between one and ten meters. The ASTM document referenced recommends a default mixing-zone depth of two meters. DAFs generated by the equations presented typically range from 1 to 10, dependent largely on annual rainfall, the hydraulic conductivity of the groundwater-bearing media, and the hydraulic gradient of the groundwater.

GENERATION OF TIER 2 SALs FOR DIRECT-EXPOSURE CONCERNS

Direct-Exposure Model Equations

The risk-based, deterministic models incorporated into the DETIER2 spreadsheet are based on slight modifications of direct-exposure models presented in the Second Half, 1994, and First Half, 1995, editions of EPA Region IX's "Preliminary Remediation Goals (PRGs)" (Appendix E, USEPA, 1994a, 1995). The equations used in the PRG models reflect guidance provided in the California EPA document entitled "Preliminary Endangerment Guidance Manual, January, 1994" (CAEPA, 1994). A copy of this document is available from the DOH Solid and Hazardous Waste Branch.

Direct-exposure SALs for carcinogenic contaminants are calculated by solving equation 4-1 in the First Half, 1995, PRGs for C (refer to Appendix E). SALs for non-carcinogenic contaminants are similarly calculated by solving equation 4-2 for C. Note that the volatilization factor term in the direct-exposure models is replaced with the particulate emission factor term for non-volatile contaminants (defined as having a Henry's Law Constant ($\text{atm}\cdot\text{m}^3/\text{mol}$) less than or equal to 10^{-3} and a molecular weight less than 200 grams/mol).

In both equations, the air dispersion term incorporated into the volatilization and particulate emission factors should be modified to allow input of site-specific data. This

reflects guidance presented in earlier editions of the PRGs. Refer to the discussion at the beginning of Appendix E for details on this modification.

Direct-Exposure Model Procedures

Procedures regarding use of the Tier 2 direct-exposure spreadsheet to generate Tier 2 SALs are described below. Refer to the example printout in Appendix I.

- Step 1. Check with the DOH Solid and Hazardous Waste Branch to ensure that the spreadsheet you have is the most up-to-date version.
- Step 2. Check with DOH to ensure that the default toxicity data provided in the spreadsheet is up-to-date.
- Step 3. Input physio-chemical and toxicity constants for the contaminant being evaluated. Constants for common contaminants are provided at the end of the spreadsheet (use "cut & paste" function of spreadsheet; refer also to tables 2-5 and 2-7). Contact the DOH Solid and Hazardous Waste Branch to obtain constants for contaminants not listed.
- Step 4. Input site data where required and otherwise available (see page 1 of spreadsheet in Appendix I). Model will use default, conservative parameter values where site data is not available. Site parameters and default values (where applicable) incorporated into the Tier 2 direct-exposure models are noted in Table 2-9.

With the exception of windspeed, the default parameter values presented are the same as those used in the EPA PRG tables. The default windspeed of 2.5m/s given reflects one-half the 11mph average windspeed reported for Honolulu International Airport between 1985 and 1993 (USDOC, 1985-1993). (The average windspeed is divided by half to take into account interference by buildings, etc., in developed areas.)

- Step 5. Spreadsheet generates the contaminants Tier 2 SAL for direct-exposure concerns at the site. Complete the information at the end of the first page of the spreadsheet. Include a copy of the spreadsheet for each contaminant modeled with the Tier 2 report submitted to DOH for review and approval (omit the equation check and physio-chemical constant table). If more than one contaminant is present above DOH Tier 1 criteria then contaminant-specific risks and hazard quotients should be added for final evaluation of the site.

An example printout of the DETIER2 spreadsheet is presented in Appendix I. A similar direct-exposure spreadsheet is available for use in Tier 3 site assessments (Appendix J, discussed below). Tier 1 direct-exposure SALs are given in Appendix F.

All site-specific parameter values used in the models must be supported by data

collected from the subject site or from appropriate referenced sources. The data must be properly presented in a document submitted to the DOH for review (e.g., in a "Final Cleanup Progress Report" submitted to the DOH for underground storage tank release responses).

Default Exposure Assumptions

Default, Tier 2 (and Tier 1) exposure assumptions are consistent with assumptions regarding residential exposure used in the EPA Region IX PRGs (Table 2-10). As in the PRG models, the Tier 2 models conservatively assume full exposure to a contaminant through inhalation, ingestion, and dermal absorption in a residential setting. Refer to the PRG reports in Appendix E for further discussion of the models and input assumptions.

MAXIMUM-ALLOWABLE SOIL ACTION LEVELS

The site soil action level for any given contaminant should not exceed that contaminants Tier 1, theoretical saturation limit in soil. SESOIL generated saturation limits for common contaminants are given in Appendix F. Saturation levels for contaminants not included in the appendix should be derived by inputting the Tier 1 model scenario into the SESOIL application and following procedures described at the end of Appendix D (or contact DOH).

COMPARISON OF GROUNDWATER-PROTECTION AND DIRECT-EXPOSURE SALs

Final, contaminant-specific soil action levels for a site are determined by comparing the results of the groundwater-impact models and direct-exposure models and selecting the SAL that corresponds to the impact of most concern (i.e., the most stringent action level) for the site. Four examples of Tier 2 site evaluations results are provided in Appendix I. Facilities should submit results of their evaluations in a similar format. Final closure reports for sites should include the results of the Tier 2 evaluation and include printouts of all model results. Report formats should follow guidance presented in the DOH TGM and subsequent updates (HIDOH, 1992, 1995a, 1995b, 1995c, 1995d). SESOIL and direct-exposure model results will be verified by DOH before final approval. Documentation of site-investigation data used in the models should be included or referenced in the report. Note that a map (drawn to scale) denoting the areal extent and thickness (use cross sections if necessary) of impacted soil left in place at the site must be submitted for all contaminants that exceed Tier 1 SALs.

APPLICATION TO SITES WITH IMPACTED GROUNDWATER

As discussed in Chapter 1 for Tier 1 soil action levels, remediation of the impacted soils at sites where the main mass of contaminant has already reached and impacted groundwater should be guided in part by actual groundwater monitoring. In some cases, a groundwater investigation may indicate that impacted soil is not adversely impacting groundwater even though DAF-modified, Tier 2 SALs generated with SESOIL are exceeded (i.e., the theoretical SALs are too conservative). If this is the case,

remediation of the impacted soil should be guided by direct-exposure concerns rather than groundwater-protection concerns. Conversely, a groundwater investigation may indicate that more stringent soil cleanup levels are warranted at the site (i.e., the theoretical SALs are not conservative enough). DOH anticipates the latter case will be the exception rather than the rule.

Groundwater contamination in excess of Tier 1 action levels may not necessarily require active remediation. When groundwater contamination in excess of Tier 1 action levels is discovered at a site, the extent and magnitude of contamination should be determined. If continued monitoring and, where appropriate, groundwater contaminant fate-and-transport modeling suggest that the plume of contaminated groundwater is not likely to migrate offsite and adversely impact groundwater extraction wells or surface water bodies then the contaminated groundwater can be left in place and allowed to degrade naturally over time. If this cannot be demonstrated then the contaminated groundwater should be actively remediated to Tier 1 action levels. Note that conclusions drawn from the results of contaminant fate-and-transport models must be supported by follow-up groundwater monitoring.

Unless otherwise approved or directed by DOH, downgradient monitoring of the plume can be discontinued when three successive seasonal cycles (generally three successive years) of groundwater monitoring indicate that the contaminated groundwater is not likely to migrate offsite and impact groundwater extraction wells or bodies of surface water at greater than Tier 1 action levels (i.e., the plume is stabilized). Monitoring of the body of groundwater that exceeds Tier 1 action levels should, however, be continued until contaminant levels drop below the action levels for two successive seasonal cycles. At this time DOH will issue a letter that no further investigative or remedial action is required at the site. Groundwater that is discharged from the site due to construction activities, etc., prior to this time must be tested for appropriate contaminants and adhere to discharge requirements put forth by the DOH Clean Water Branch.

TIER 3 RISK ASSESSMENTS

Tier 3 risk assessments should follow guidelines presented in the DOH TGM and subsequent updates (HIDOH, 1992, 1995a). Risk assessments developed at this level might include some combination of alternative vadose-zone fate-and-transport models, direct-exposure models, and exposure pathway evaluations as well as more complex groundwater fate-and-transport models. All Tier 3 models and model assumptions must be fully documented and submitted to DOH for review and approval.

In the Tier 3 RBCA framework, the facility is allowed to propose alternative, acceptable levels of risk at the site. DOH recommends, however, that the target risk following completion of remedial actions be set at 10^{-6} . If a facility cannot feasibly meet this primary objective, however, but can get to within the EPA-designated acceptable risk range of 10^{-4} to 10^{-6} , then the facility should meet with the appropriate DOH office and demonstrate that additional remedial work cannot feasibly be carried out, given technological and economic constraints, etc. In reality, this may be a common scenario

at large sites with extensive but relatively low levels of contamination.

DOH has prepared a direct-exposure spreadsheet for Tier 3 site evaluations (DETIER3). An example printout of the spreadsheet is provided in Appendix J. Incorporation of the spreadsheet in the Tier 3 evaluation is not required, though its use may help expedite review of the risk assessment.

The spreadsheet can also be used to calculate risk due to volatilization from groundwater (required only on a site-by-site basis by DOH). Simply assume that 90% of the total porosity is water-filled/saturated and run the model as usual (e.g. if total porosity = 43%, soil is 90% saturated when soil moisture content = 0.25ml/g.).

Table 2-1. Example generation of Tier 2 SALs. Site - Inland area over basal, unconfined, drinking water groundwater system in basalt; base of impacted soil \geq 10m above top of groundwater; moderate rainfall (150cm/year); areal extent of soil impacted above Tier 1 SALs = 900m², thickness of soil impacted above Tier 1 SALs = 2m (assumed same for each contaminant)

| ¹ Contaminant | ² SESOIL SAL (mg/kg) | ³ Site DAF | ⁴ Groundwater Protection SAL (mg/kg) | ⁵ Direct-Exposure SAL (mg/kg) | ⁶ SAL chosen for site (mg/kg) |
|--------------------------|---------------------------------|-----------------------|---|--|--|
| Benzene | 0.027 | 2.5 | 0.07 | 6.8 | 0.07 |
| Toluene | 124 | 2.5 | ⁴ 170sat | 5340 | 170 |
| PCE | 2.3 | 2.5 | 5.8 | 5.8 | 5.8 |

1. Contaminants noted exceeded Tier 1 soil action levels (SALs) at the example site.
2. Default Tier 1 SESOIL SALs for groundwater protection taken from lookup table rather than re-running SESOIL to generate site-specific SALs for groundwater protection (refer to Appendix F, Table 1a).
3. Site dilution attenuation factor (DAF) as calculated using DAF spreadsheet.
4. Site SALs for groundwater-protection concerns calculated by multiplying the SESOIL SAL times the leachate dilution attenuation factor determined for the site. Maximum groundwater-protection SAL is the contaminants theoretical saturation limit ("sat", refer to Appendix F, Table 2).
5. Contaminant direct-exposure SALs as calculated using DETIER2 spreadsheet.
6. SAL chosen for site reflects the contaminant pathway of most concern.

TABLE 2-2. Tier 1 and Tier 2 groundwater protection standards

| Contaminant | ^{1,2} Current/Potential Drinking Water Resource (mg/l) | ^{1,3} Non-Drinking Water Resource (mg/l) |
|----------------|---|---|
| Benzene | 0.005 | 1.7 |
| Toluene | 1.0 | 2.1 |
| Ethylbenzene | (0.14) | 0.14 |
| Xylene | 10 | [10] |
| Benzo(a)pyrene | 0.0002 | [0.0002] |
| Acenaphthene | (0.32) | 0.32 |
| Fluoranthene | (0.013) | 0.013 |
| Naphthalene | ⁵ 0.24 | 0.77 |
| PCE | 0.005 | ⁴ 0.145 |
| 1,1 DCE | 0.046 | 3.9 |
| Vinyl Chloride | 0.00002 | [0.00002] |
| TCE | 0.005 | 0.70 |
| 1,1,1 TCA | 0.20 | 6.0 |
| Lead (total) | (0.0056) | ⁴ 0.0056 |
| Cadmium | 0.005 | ⁴ 0.0093 |
| PCBs | 0.0005 | ⁶ 0.002 |

- () Same as surface water; surface-water standard more stringent than drinking water standard.
 [] Same as drinking water; surface-water standards not set.
1. Groundwater utility as defined by DOH (refer to HDOH, 1995b).
 2. Drinking water MCL for contaminant unless otherwise noted (HAR Chapter 11-20, 1994).
 3. Surface water acute standard (or chronic standard where available and applicable) for contaminant unless otherwise noted (HAR Chapter 11-54, 1992).
 4. Marine chronic surface water quality standard as established in HAR, HAR 11-54.
 5. Drinking water criteria provided in USEPA Region IX Preliminary Remediation Goals document (USEPA, 1995).
 6. Ecology-based, freshwater acute standard used for PCBs. Both freshwater and chronic standards are based on FDA action levels for PCBs in fish for commercial consumption rather than ecological impact.

Table 2-3. Site parameters and default values used in Tier 1 SESOIL models

| | | | |
|--|-------------------------------------|--|--|
| <u>Climate Data:</u> | | <u>¹Default Values</u> | |
| Air Temperature: | | month-specific | |
| Evapotranspiration (cm/day): | | 36% of rainfall, month specific | |
| Precipitation (cm/month): | | 200cm/year, month-specific | |
| Storm Duration (days) | | month-specific | |
| Number of Storms: | | month-specific | |
| Days per Month: | | 30.4 (default, all months) | |
| | | | |
| <u>Soil Properties:</u> | | | |
| Bulk Density (g/cm ³): | | 1.3 | |
| Intrinsic Permeability (cm ²): | | specified in soil column input | |
| Disconnectedness Index: | | 3.5 | |
| Effective Porosity: | | 0.3 | |
| Organic Carbon Content (%): | | 0.1 | |
| Cation Exchange Capacity (meq/100g): | | 0 | |
| Freundlich Equation Exponent: | | 1.0 | |
| | | | |
| <u>Soil Column Properties:</u> | | | |
| <u>Layers</u> | <u>²Thickness</u> | <u>³Permeability</u> | <u>⁴Organic Carbon</u> |
| soil | site specific | 1E-07cm ² | 0.1 % |
| basalt/bedrock | site specific | 1E-06cm ² | 0.0001 % |

1. Refer to default values presented in Table 2-4 for month-specific data.

2. Total thickness reflects assumed depth to groundwater.

3. Values used in Tier 1 models. Refer to Table 2-5 for default permeability values.

4. Foc as a fraction of input soil property value.

TABLE 2-4. Monthly climate data used in Tier 1 SESOIL standard-rainfall models.
(Modified Ahuimanu Loop climate station data)

| Month | ¹ Air Temperature (°C) | ² Evapotranspiration (cm/day) | ³ Precipitation (cm/month) | Duration (days) | Number of Storms | Month Length (days) |
|-------|-----------------------------------|--|---------------------------------------|-----------------|------------------|---------------------|
| Oct. | 25 | 0.21 | 12.02 | 0.31 | 12.2 | 30.4 |
| Nov. | 24 | 0.24 | 14.06 | 0.36 | 12.2 | 30.4 |
| Dec. | 23 | 0.28 | 15.90 | 0.43 | 11.1 | 30.4 |
| Jan. | 22 | 0.39 | 22.54 | 0.50 | 10.0 | 30.4 |
| Feb. | 22 | 0.22 | 12.88 | 0.35 | 10.1 | 30.4 |
| Mar. | 22 | 0.28 | 16.37 | 0.33 | 12.6 | 30.4 |
| Apr. | 23 | 0.27 | 15.32 | 0.36 | 13.6 | 30.4 |
| May | 24 | 0.18 | 10.68 | 0.27 | 13.0 | 30.4 |
| June | 25 | 0.14 | 7.87 | 0.26 | 11.5 | 30.4 |
| July | 25 | 0.14 | 8.10 | 0.29 | 12.5 | 30.4 |
| Aug. | 25 | 0.16 | 9.19 | 0.26 | 12.8 | 30.4 |
| Sept. | 25 | 0.14 | 7.92 | 0.23 | 11.8 | 30.4 |

Annual Totals: Precipitation: 200cm, Evapotranspiration: 80cm, Surface Runoff: 48cm (Groundwater Recharge = 72cm)

1. Air temperature data from Kāne'ohe Mauka climate station (Owenby and Ezell, 1992). All other data modified from 'Āhuimanu Loop climate station.
2. Evapotranspiration calculated as 40% of daily rainfall.
3. 'Āhuimanu Loop monthly precipitation adjusted to produce 200cm annual rainfall versus actual 223cm/yr. Input precipitation reduced by 24% to account for surface runoff.

TABLE 2-5. Physical properties of basalt and common soil types in Hawai'i

| Properties | Basalt | Saprolite (a)/ silty sediment | Saprolite (b) | Clay (c) | Sand |
|---------------------------------------|--------------|----------------------------------|------------------|-----------------|--------------|
| Range Hydraulic Conductivity (in/hr) | - | 2 to 6 | 0.6 to 2.0 | 0.06 to 0.2 | 6 to 20 |
| Range Hydraulic Conductivity (m/d) | up to 300 + | 1 to 4 | 0.1 to 0.4 | 0.04 to 0.12 | 4 to 12 |
| Range Permeability (cm ²) | 1E-8 to 4E-6 | 1E-8 to 5E-8 | 5E-9 to 1E-8 | 5E-10 to 5E-9 | 5E-8 to 1E-7 |
| Model Hydraulic Conductivity (m/d) | 100 | 4 | 0.4 | 0.2 | 12 |
| Model Permeability (cm ²) | 1E-06 | 5E-08 | 5E-09 | 2E-9 | 1E-07 |
| Organic Carbon at > 50cm depth (%) | no data (0%) | 0 to 1.0% | 0 to 1.0% | highly variable | 0 to 0.1% |
| Bulk Density (g/cm ³) | 1.6 | 1.3 | 1.3 | 1.3 | 1.7 |

Saprolite (a): Silty clay - Wahiawā, Helemano, Waikāne, Loleka'a soil series.

Saprolite (b): Silty clay - 'Ewa, Waialua soil series.

Clay (c): Lualualei, Ka'ena series.

Sources of published data:

1. Soil Survey of the Islands of Kaua'i, O'ahu, Maui, Moloka'i, and Lāna'i, State of Hawai'i (Foote et al., 1972);
2. Soil Survey Laboratory Data and Descriptions for Some Soils of Hawai'i (USDOA, 1976);
3. Hydrogeologic Characteristics of Subsoil and Saprolite and Their Relation to Contaminant Transport, Central O'ahu, Hawai'i (Miller et al., 1988);
4. Aquifer Identification and Classification for O'ahu (Mink and Lau, 1990);
5. Hawai'i Field Office Technical Guide (Section II, Engineering Index Properties, USDOA, 1992).

TABLE 2-6. Default, physio-chemical constants for common contaminants

| ¹ Constituent | Water Solubility (mg/l) | Diffusion Coefficient-air (cm ² /s) | Henry's Constant (m ³ -atm/mole) | KOC (ml/g) | Molecular Weight |
|-----------------------------|-------------------------|--|---|------------|------------------|
| Benzene | 1800 | 0.088 | 0.0055 | 65 | 78 |
| Toluene | 520 | 0.078 | 0.0066 | 260 | 260 |
| Ethylbenzene | 680 | 0.075 | 0.0079 | 220 | 110 |
| Xylene (mixed) | 200 | 0.087 | 0.0053 | 240 | 110 |
| ² Benzo(a)pyrene | 0.0039 | 0.045 | 0.0000024 | 881000 | 252 |
| Acenaphthene | 4 | 0.064 | 0.0012 | 4600 | 150 |
| ² Fluoranthene | 0.26 | 0.051 | 0.0000087 | 41700 | 202 |
| Naphthalene | 31 | 0.069 | 0.0013 | 1300 | 130 |
| PCE | 150 | 0.072 | 0.023 | 660 | 170 |
| 1,1 DCE | 400 | 0.079 | 0.15 | 65 | 97 |
| Vinyl Chloride | 1100 | 0.110 | 0.70 | 57 | 63 |
| TCE | 1000 | 0.081 | 0.0089 | 130 | 130 |
| 1,1,1 TCA | 950 | 0.080 | 0.0028 | 150 | 130 |

1. Source of data USEPA (1995) unless otherwise noted.
2. Data after Montgomery and Welkom (1991) and Neff et al. (1994).

TABLE 2-7. Default biodegradation constants for use in Tier 2 SESOIL models

| Constituent | Range Aerobic Half- life (days) | Range Anaerobic Half- life (days) | Model Liquid-Phase Half-life (days) | Model Liquid- Phase Biodegradation Rate (1/days) | Model Solid- Phase Biodegradation Rate (1/days) |
|----------------|---------------------------------------|---|--|---|--|
| Benzene | 5 to 16 | 112 to 730 | 112 | 0.0062 | 0.0031 |
| Toluene | 4 to 22 | 56 to 210 | 56 | 0.0124 | 0.0062 |
| Ethylbenzene | 3 to 10 | 176 to 228 | 176 | 0.0039 | 0.0020 |
| Xylene (mixed) | 7 to 28 | 180 to 365 | 180 | 0.0039 | 0.0019 |
| Benzo(a)pyrene | 56 to 529 | 228 to 2117 | 529 | 0.0013 | 0.0007 |
| Acenaphthene | 12.3 to 102 | 49.2 to 408 | 102 | 0.0068 | 0.0034 |
| Fluoranthene | 140 to 440 | 558 to 1774 | 558 | 0.0012 | 0.0006 |
| Naphthalene | 0.5 to 20 | 25 to 258 | 25 | 0.0277 | 0.0139 |
| PCE | 180 to 365 | 98 to 1643 | 365 | 0.0019 | 0.0009 |
| 1,1 DCE | 28 to 180 | 81 to 173 | 180 | 0.0039 | 0.0019 |
| Vinyl Chloride | 28 to 180 | 112 to 730 | 180 | 0.0039 | 0.0019 |
| TCE | 180 to 365 | 98 to 1642 | 365 | 0.0019 | 0.0009 |
| 1,1,1 TCA | 140 to 273 | 560 to 1092 | 560 | 0.0012 | 0.0006 |

Half-life data after Howard et al. (1991).

TABLE 2-8. Toxicity data for common contaminants

| Contaminant | Cancer Slope Factor (oral) [1/(mg/kg-d)] | Cancer Slope Factor (inhalation) [1/(mg/kg-d)] | Reference Dose (oral) [mg/kg-d] | Reference Dose (inhalation) [mg/kg-d] |
|----------------|--|--|---------------------------------------|---|
| Benzene | 2.90E-02 | 2.90E-02 | | |
| Toluene | | | 2.00E-01 | 1.10E-01 |
| Ethylbenzene | | | 1.00E-01 | 2.90E-01 |
| Xylene | | | 2.00E + 00 | 2.00E-01 |
| Benzo(a)pyrene | 7.30E + 00 | 7.30E + 00 | | |
| Acenaphthene | | | 6.00E-02 | 6.00E-02 |
| Fluoranthene | | | 4.00E-02 | 4.00E-02 |
| Naphthalene | | | 4.00E-02 | 4.00E-02 |
| PCE | 5.20E-02 | 2.00E-02 | 1.00E-02 | 1.00E-02 |
| 1,1 DCE | 6.00E-01 | 1.80E-01 | 9.00E-03 | 9.00E-03 |
| Vinyl Chloride | 1.90E + 00 | 3.00E-01 | | |
| TCE | 1.1E-02 | 6.0E-03 | 6.0E-03 | 6.0E-03 |
| 1,1,1 TCA | | | 9.0E-02 | 2.9E-01 |

Source of data: USEPA IRIS and HEAST data bases (USEPA, 1994b, 1994c)

TABLE 2-9. Direct-exposure site parameters and default values

| | ¹ Default Values |
|--|-----------------------------|
| Areal extent of contamination (meters ²) | 2025m ² |
| Soil density (grams/meter ³) | 1.50g/m ³ |
| Particle density (grams/meter ³) | 2.65g/m ³ |
| Soil porosity (total) | 43% |
| Soil air-filled porosity | 28% |
| Soil moisture content (milliliters water/grams soil) | 10ml/g |
| Fraction organic carbon | 0.02 |
| Average wind speed (meters/second) | 2.5m/s (5.5mph) |

1. Same as used for EPA Region IX Preliminary Remediation Goals (USEPA, 1995).

TABLE 2-10. Direct-exposure human-receptor parameters and default values

| Human Receptor Data | Default |
|--|---------|
| 25% surface area - adults (cm ²) | 5000 |
| 25% surface area - children (cm ²) | 2000 |
| Adherence factor (unitless) | 0.2 |
| Inhalation Rate - adults (m ³ /d) | 20 |
| Inhalation Rate - children (m ³ /d) | 10 |
| Soil ingestion rate - adults (mg/d) | 100 |
| Soil ingestion rate - children (mg/d) | 200 |
| Exposure time - residents (h/d) | 24 |
| Exposure frequency - residents (d/y) | 350 |
| Exposure duration - residents total (yrs) | 30 |
| Exposure duration - children (yrs) | 6 |
| Body weight - adult (kg) | 70 |
| Body weight - child (kg) | 15 |
| Averaging time (yrs) | 70 |
| Other variables | |
| Diffusion height (m) | 2 |

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Appendix 5D

Guidelines for Tier 3 Human Health Risk Assessments

Tier 3
GUIDELINES FOR HUMAN HEALTH RISK ASSESSMENT

HAWAII DEPARTMENT OF HEALTH
HAZARD EVALUATION & EMERGENCY RESPONSE

INTRODUCTION

In a world with unlimited resources, every molecule of contaminant would be removed during a site cleanup. This concept is now known to be unrealistic, given the limited resources that are available for addressing contaminated sites. Cleanup levels that are above background yet protective of human health and the environment can be established through the process of risk assessment.

In order to streamline the cleanup process, Hawaii's Hazard Evaluation and Emergency Response (HEER) Office has derived preliminary action levels to determine whether additional work is warranted at the site. HEER recognizes that these screening levels may not be appropriate for all sites. For sites that are not eligible for the numerical screening levels, quantitative risk assessment can establish alternative values.

The goal of a risk assessment is to assess the health risks from exposure to potentially hazardous compounds in order to determine whether there is a need to clean up and to provide information for selection of the best remedy for the site. Risk assessments can be time consuming and costly, therefore before deciding on this approach, it is necessary to consider carefully the reason for choosing this option instead of removing and/or treating the contamination. If after careful consideration in consultation with the HEER office it is decided that a risk assessment is warranted, the following guidance is provided to assist risk assessors in preparation of the risk assessment report.

This document is intended to serve the following purposes:

- 1) To provide specific guidance from the Hawai'i Department of Health HEER office for human health risk assessment.

The general guidance for human health risk assessment at the Department will be based on the Risk Assessment Guidance for Superfund (RAGS), U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response (OSWER) Directive 9285.701a (RAGS).

- 2) To highlight some of the specific points in the Risk Assessment Guidance for Superfund which are deemed especially important by the Department. Note: This document is not meant to be an exhaustive review or outline of RAGS.

These Department of Health Risk Assessment Guidelines are to be followed for any human health risk assessment prepared for all applicable Hazard Evaluation and Emergency Response sites within Hawai'i. Site-specific risk assessments are reviewed by the HEER office for conformance with these guidelines prior to acceptance of the risk assessment for use in the program.

The goal of the HEER program is to use human health risk assessments that are as realistic as possible, within the framework of the Department's risk assessment and risk management policies and the uncertainties of the risk assessment process.

These Human Health Risk Assessment Guidelines are organized into 7 Sections:

1. **General Comments**
2. **Data Collection**
3. **Data Evaluation**
4. **Exposure Assessment**
5. **Toxicity Assessment**
6. **Risk Characterization**
7. **Report Format/Review**

Section 1: GENERAL COMMENTS

Early Involvement of Risk Assessors:

Risk assessors must become involved early in the course of a site investigation. This is the single most important feature of the U.S. EPA Risk Assessment Guidance for Superfund and the Department of Health Risk Assessment Guidelines for Human Health Risk Assessment.

The quality of a risk assessment is dependent on the adequacy of the sampling and analysis for contamination during the site investigation, as well as a number of other factors preceding the actual quantitative analysis of risk and writing of the risk assessment itself. It is therefore imperative that the risk assessor be an active member of the investigation and remediation team during the *entire* course of a project.

It is especially important that the risk assessor be consulted prior to development of the sampling and analysis plan for the site. Data needs for quantitative risk assessment can differ from those for identifying the "nature and extent" of contamination or

determining the effectiveness of remediation. An adequate sampling and analysis plan generally requires the input of an experienced risk assessor who can apply professional judgement to identify risk assessment concerns requiring special data needs (e.g., potential exposure pathways, hotspots, alternative land use scenarios).

The importance of early involvement of the risk assessor(s) cannot be overemphasized.

Early Involvement of Oversight Agencies:

The corollary to early involvement of the risk assessors is early involvement of the Department and any other oversight agencies. Development of a risk assessment should proceed as a interactive process between the risk assessor and the oversight agency(ies). Approval of the risk assessment by the Department will be more likely, and expeditious, if all questions regarding exposure assumptions, contaminant concentration terms, land use scenarios and other risk assessment parameters are settled during the development of the risk assessment.

Phased Approach to Risk Assessment:

In general, the most productive way to conduct a human health risk assessment is via a phased approach, in which the risk assessor employs an increasingly complex level of detail (and effort) at each step. Two general phases are recommended:

Phase 1: Screening-Level Assessment Based On Reasonable Maximum Exposure Assumptions:

A screening-level assessment uses conservative exposure assumptions to rapidly and simply identify which contaminants, exposure pathways and/or exposure scenarios at a site clearly pose no risk to human health. When employed early in the process, a screening-level assessment allows the risk assessor to eliminate insignificant contaminants, exposure pathways and/or exposure scenarios from the more labor-intensive, quantitative risk assessment.

Note: If the screening-level assessment generates cancer risk or Hazard Quotient values exceeding risk screening levels for some contaminants, exposure pathways or exposure scenarios it is not appropriate to conclude that these pose a *significant* risk. Exceedance of risk screening levels in this type of assessment only indicates that a more detailed risk analysis is required to determine if a significant risk exists (screening level assessments are appropriate **ONLY** to identify contaminants, exposure pathways and/or exposure scenarios which clearly do not pose a significant risk).

Risk-Based Screening: Suggested Approach:

The Hawai'i Department of Health has established the following risk screening levels for eliminating contaminants, exposure pathways or exposure scenarios from further consideration in a risk assessment when a worst-case analysis indicates their potential risks are:

For contaminants in water:

Cancer risks less than/equal to 10^{-6} .
Hazard Quotients less than/equal to 1.0

For contaminants in soil:

Cancer risks less than/equal to 10^{-6} .
Hazard Quotients less than/equal to 1.0.

These risk screening levels are based on the lower end of the target risk range set for the U.S. EPA Superfund program in the National Contingency Policy (NCP). The Department assumes that if no single contaminant sample exceeds a concentration representing a health risk at the lower end of this range that combined exposure to contamination at the site will not pose a significant risk to human health.

The screening of contaminants should compare the maximum concentration of each contaminant detected at the site to Hawaii's Tier 1 or 2 preliminary action levels. Chemicals exceeding these screening concentrations should be carried through the risk assessment.

Phase 2: Detailed Risk Assessment Based On Realistic Point Estimates:

Contaminants, exposure pathways and exposure scenarios which were not eliminated by the screening-level assessment are carried forward to the next phase of risk assessment. In this second phase, a detailed quantitative risk assessment is performed using realistic point estimates for the exposure parameters. This detailed risk assessment will typically address two levels of exposure for each pathway and scenario in the assessment, resulting in two corresponding point estimates of risk for the exposed population(s):

- **Central Tendency:** An estimate of the average or median individual risk for the exposed population. The Central Tendency risk estimate is typically based on average assumptions or data about the population's exposure to contaminants from the site.

For example: When developing a Central Tendency risk estimate for a

residential scenario, duration of exposure is usually assumed to be 9 years. This is based on national data which indicate that the average family in the U.S. changes its residence every 9 years.

- **High End:** A plausible estimate of risk for those people at the upper end of the risk distribution in the exposed population. The High End assessment attempts to estimate risks for individuals above the 90th percentile of risk distribution, but to not be higher than risk to that individual in the population who experiences the highest actual exposure to contaminants at the site. The High End risk estimate is typically based on upper confidence or near maximal assumptions or data relating to the population's exposure to contamination from the site.

Further information on calculating and using Central Tendency and High End risk estimates, including typical exposure assumptions for each type of estimate, is presented in:

Habicht H: Guidance on Risk Characterization for Risk Assessors and Risk Managers. EPA policy memorandum, 26 February 1992.

U.S. EPA: Exposure Factors Handbook. Office of Health and Environmental Assessment (OHEA), EPA600/8-89/043.

Actual Current Exposures:

Of the various exposure scenarios included in a human health risk assessment, the most important to evaluate are actual current exposures to contamination from the site (as opposed to future possible exposures). This is especially important in light of a tradition in risk assessment to concentrate on investigation and assessment of groundwater contamination, with relatively lessor attention being paid to airborne exposures. When identifying actual current exposures, careful attention should be given the existence of any indirect, or secondary, exposure pathways. Professional judgement of an experienced risk assessor is important in assuring that all current exposure pathways are identified for inclusion in the risk assessment.

Exposures via inhalation of airborne contamination, either as fugitive dust or volatilization, are often overlooked in the initial identification of current or potential exposure pathways. This is especially important with regard to indoor inhalation exposures. Vapors from soil can enter enclosed spaces, especially if they are poorly ventilated such as basements, and create significant exposures.

Direct monitoring of potential exposure situations should be considered when the possibility for actual current exposures exists at a site.

Section 2: DATA COLLECTION

Risk Assessment Data Needs:

EPA's Risk Assessment Guidance for Superfund notes:

The sampling strategies for a site must be appropriate for use in a quantitative risk assessment; if [the sampling strategy is] inappropriate, even the strictest [quality assurance/quality control] procedures ... will not ensure the usability of the sample results (RAGS section 4.6).

Many of the recommendations in this section are based on specific data needs for human exposure pathway evaluation or other critical components of the risk assessment. Design of a appropriate data collection effort requires a preliminary identification of the potential human exposure pathways at the site. This task requires the professional judgement of an experienced risk assessor and is one of the most important reasons for early involvement of the risk assessor in the site evaluation project.

Background Sampling:

A sufficient number of background samples should be obtained for each contaminated media (soil, air, groundwater, etc.) at the site. An appropriate number of background samples might equal 5-10% of the number of samples collected, of each media, to define nature and extent of contamination. If the total number of samples collected is less than 10, a minimum of 5 background samples should be collected for each media.

locations may be required for other aspects of the site investigation. The risk assessor should evaluate the site investigation data to determine which are applicable to risk assessment and include only those data in the exposure assessment. (Any data which are thus eliminated or not considered in the risk assessment should be identified and a justification for their removal should be presented.) For example, EPA's Risk Assessment Guidance for Superfund notes:

Samples from areas where direct contact is not realistic (such as where a steep slope or thick vegetation prevents current access) should not be considered when estimating current exposure concentrations (RAGS section 6.5.3).

Purposive vs. Random Sampling:

Random selection of sampling locations usually provides the most useful data for human health risk assessment; randomly obtained data can generate meaningful statistical expressions of contaminant concentrations for use in exposure assessment. However, purposive or directed targeting (i.e., sampling directed at areas known or thought to have experienced contamination) is often necessary to ensure that significant contamination is discovered in the investigation and addressed in the risk assessment; this is especially important when investigating a large, non-uniform site.

Therefore, a purposive or directed approach should be used to target areas of concern at a large site where contamination is not uniform across the entire site. This directed approach should be used to identify general areas of the site known or expected to have been affected by contamination. Within the individual areas of concern specific sampling locations then should be chosen at random using a grid system. This will allow a meaningful estimation of the exposure potential within each area of concern, while ensuring that general areas of known or expected contamination at large sites are included in the assessment.

Systematic sampling (i.e., collection of samples from all points specified by a uniform grid over the entire site or area of concern) has many of the same advantages for human health risk assessment as random sampling; especially the ability to calculate a meaningful statistical concentration term for exposure assessment. This approach may be preferred in situations where the goal is to find suspected hotspots within a larger, less contaminated, site or area of concern.

Chemical Speciation:

It is important for the human health risk assessment to distinguish between different species of the same chemical or different congeners of a chemical class when there are appreciable toxicity differences between them. Speciation of such contaminants must be

arranged during planning of the data collection and laboratory analysis phases of the site investigation.

For example:

- Chromium VI (Cr VI) is carcinogenic by inhalation, Chromium III (Cr III) is not - the site investigation must provide specific data on Cr VI and Cr III concentrations, as opposed to data on "total chromium", to enable the risk assessment to accurately estimate health risks from chromium exposures.
- The various polychlorinated dibenzo dioxins (PCDDs) and polychlorinated dibenzo furans (PCDFs) have different relative toxicity potentials - accurate assessment of "dioxin" risks requires speciation of the various PCDD/PCDF congeners during the site investigation.

Degradation Products:

The risk assessment should address any potential degradation products of the contaminants at the site and should estimate health risks from these degradation products. Chemical, biological and physical degradation should be considered, as well as the rate of such degradation (i.e, rate of formation of potentially toxic products).

The data collection phase of the site investigation must therefore include sampling and analysis provisions for any potential degradation products of contaminants known or suspected at the site.

For example, some chemicals for which this is especially important include:

- Dioxin can be a product of combustion or high temperature degradation of chlorinated organics - the potential for dioxin formation should be addressed at sites where chlorinated organics (or coexisting chlorine and organics) are/where subject to combustion or high temperatures.
- Vinyl chloride is an environmental breakdown product of certain chlorinated solvents (e.g., trichloroethylene) - the potential for vinyl chloride formation should therefore be assessed at sites contaminated with these solvents.
- Ethylene thiourea can be a breakdown product from thiocarbamate fungicides.

Surface Soil:

In the event of potential surface soil contamination, true surface samples should be collected on-site (and off-site if contamination is thought to have spread) in order to

characterize the potential for exposure via soil ingestion and inhalation of fugitive dust. Samples taken many inches, or feet, below the surface do not qualify as surface soils. This is especially important because exposure to contaminants in surface soil is often an actual current exposure, whereas exposure to deeper contamination is usually a potential future exposure pathway.

There is some information in the literature to indicate that an "active" zone for exchange of surface chemicals can extend 12-18" below the surface (deeper for soils subject to disturbance activities such as tilling, shallower for undisturbed, clay-like soils). Therefore, depending upon the soil and activity characteristics of a particular site, it may be advisable to collect samples at the surface and as a composite between 6-12 inches.

Environmental Modeling and Geochemical/Physical Data:

Modeling of contaminant fate and transport in the environment, including movement of contaminants between different media, is usually required for the estimation of public exposure levels in the risk assessment. The data collection and analysis plan should ensure that appropriate geochemical and/or physical data required for modeling of such environmental fate and transport will be collected during the investigation.

For example:

- Modeling of contaminant concentrations in, and movement to and through, groundwater often requires data on geochemical characteristics of subsurface soil, such as (but not limited to):
 - porosity,
 - diffusivity,
 - hydraulic conductivity,
 - organic carbon content.
- Modeling of contaminant releases to and movement through, air for assessment of airborne exposure potential often requires data on parameters such as (but not limited to):
 - wind direction,
 - wind speed,
 - airborne dust levels.

(See **Meteorological Data**, below, for more on air modeling data requirements.)
- Modeling of potential inhalation exposures from volatilization of subsurface organic contaminants often requires data on parameters such as (but not limited to):

- total subsurface soil porosity,
- bulk density of subsurface soil,
- subsurface soil moisture content, and
- depth to contamination.

Although default values are available for some of these geochemical and physical parameters, significant uncertainty can be introduced into the exposure assessment by the use of such default values; this uncertainty can result in substantial overestimation of potential health risks (because of the conservative nature of default values and corresponding modeling assumptions, their use is more likely to overestimate than underestimate potential risks). The exact geochemical and physical data requirements will vary depending on which fate and transport models are used in the exposure assessment. For this reason, the advice of an experienced risk assessor and/or environmental modeler is usually necessary at the planning phase to identify the appropriate geochemical and physical data to be collected during the site investigation.

Meteorological Data:

Ideally, the sampling period would span a sufficient period of time to incorporate a characteristic spectrum of meteorological conditions at the site; the Department recognizes this is not always possible. EPA's Risk Assessment Guidance for Superfund states that at least two sampling events should be conducted for each contaminated media, preferably during extremes of meteorological conditions (e.g., hot weather/wet weather). The human health risk assessment should address, if only qualitatively, the effects of extreme meteorological conditions on potential exposures to contamination at the site.

The site assessment team should note that environmental fate and transport models, especially air dispersion models, may have specific data needs regarding meteorology (e.g., the Industrial Source Complex (ISC) air dispersion model requires wind speed and wind direction data spanning at least one year, preferably 5 years, as either hourly readings or an annual averages). Although such data can occasionally be obtained from State or Local agencies, these data needs must be considered when planning the data collection and analysis phase of the site investigation.

Section 3: DATA EVALUATION

Frequency of Detection Selection Criterion

Frequency of detection is often used as a screening criterion to help determine which contaminants detected at a site will be incorporated into the risk assessment. Contaminants detected in less than 5% of the samples from any one media or area are often eliminated from further assessment for that media. This practice is appropriate in many situations, however there are a number of circumstances in which frequency of

detection is not an appropriate screening criterion. The appropriate interpretation of frequency of detection at individual sites will usually require the professional judgement of an experienced risk assessor.

The potential existence of hotspots (small highly contaminated areas or locations within a larger site) of contamination or uncommon meteorological conditions and/or environmental situations (which may be represented in less than 5% of all samples) should be considered when applying frequency of detection as a screening criterion. Merely because a particular chemical is present in a low number of samples does not necessarily mean it is "not present" or does not pose a potential human health risk. Site-specific professional judgement, usually by a risk assessor intimately familiar with the site, is often required to determine which infrequently detected contaminants or situations constitute a hotspot and which constitute contamination which is insufficient for further assessment.

Background Levels of Contaminants:

Inorganic chemicals may be eliminated from the human health risk assessment during the screening phase if they are shown to be present at naturally occurring levels for the area where the site is located. Six inorganic constituents which are often analyzed for but which are not associated with toxicity to humans under normal circumstances are aluminum, calcium, magnesium, potassium, iron and sodium. No quantitative toxicity information is available for these elements from EPA sources. These six elements can generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement.

In general, organic chemicals should not be eliminated from the quantitative risk assessment on the basis of comparison with background levels (the Department assumes that natural background levels for organic chemicals is normally zero; therefore detectable levels of organics indicates contamination). However, in certain limited situations, the Department may allow the risk assessor to screen out some organic contaminants. Any decisions to allow such elimination of organic chemicals will be made on a case-by-case basis.

At the Department's discretion, the risk assessor may be requested to estimate risks associated with exposure only to background levels of contaminants at the site. If an initial risk screening analysis indicates that background contaminants may pose an appreciable health risk, this information should be discussed with the project manager and/or the Department's Toxicologists.

Limits of Detection for Contaminant Analyses:

Site-specific professional judgement by an experienced risk assessor is usually necessary

to decide how to factor "non-detects" into the human health risk assessment. Different approaches may be used for different areas of the site.

In general, "non-detects" should be factored into the exposure assessment as concentrations equal to 1/2 of the limit of detection (LOD) for calculating arithmetic means for the contaminant concentrations. This approach is most appropriate for evaluating areas of general or widespread, relatively uniform contamination.

This approach can also be useful when limits of detection are significantly greater than usual because analytical procedures were compromised by interfering compounds present in the contaminant mixture (matrix interferences). However, if the LODs are so high that inclusion of 1/2 LOD for "non-detects" would raise the average concentration above the maximally detected value, these "non-detects" should be eliminated from the quantitative risk assessment (see RAGS section 5.3.2).

It is especially important to understand that this approach should not be used to "dilute out" the impacts of hotspots or plumes of contamination (e.g., by averaging in a large number of "non-detects" from surrounding locations which are not affected by the hotspot or plume). Hotspots or plumes should be considered for separate risk assessment and remediation.

Note: These comments relate only to "non-detects" for contaminants already identified at a site. The 1/2 LOD approach should not be applied to a medium where the chemical has never been detected and there is no reason (based on site history or related information) to expect its presence. See RAGS section 5.3.5. (A possible exception is when actual detection limits for all samples are above significant health effect levels and there is good reason to expect presence of the chemical in that media. In this situation it may be necessary to collect additional samples for reanalysis by a more stringent procedure.)

Evaluating Adequacy of Detection Limits:

In order to evaluate the sufficiency of detection limits achieved by investigation's analytical procedures, a risk-based screening assessment should be performed for the contaminants of concern. In this screening assessment, the reported analytical detection limits should be compared to EPA Region IX PRGs. In the event the analytical procedures are not sufficiently sensitive to detect contaminant concentrations posing an appreciable health risk (e.g., 10^{-6} cancer risk, Hazard Quotient = 1.0), an attempt should be made to collect sufficient data. This situation usually requires additional sample collection and reanalysis by a more sensitive procedure.

Note: At present, most potential carcinogens with EPA-derived cancer slope factors (SFs) have standard limits of detection (CRQLs; Contract Required Quantitation Limits) in water

which exceed concentrations associated with a 10^{-6} cancer risk (based on 2 liter/day water consumption for a 70 kilogram individual). Special, more sensitive, analytical procedures may be required for these chemicals at some sites.

In general, only validated data should be used in a human health risk assessment performed for the Superfund (CERCLA) program. In some cases, there may be site-specific factors that allow limited use of unvalidated data; if the risk assessor believes this is the case, use of any such data should be pre-approved (prior to its inclusion in the risk assessment) by the project manager and the Department's Toxicologists.

Data Qualifiers: Exhibits 5-4 and 5-5 of RAGS present a summary of data qualifiers used by U.S. EPA and its contract laboratories.

In general, data assigned a "J" qualifier can be used in quantitative risk assessment. However, when this is done, this procedure must be clearly discussed in the risk assessment report. This discussion must address the assignment and interpretation of the "J" qualifier by both the Department and the analytical laboratory as well as the possible effect this procedure has on the uncertainty of the risk assessment. Risk tables or summaries should be footnoted to *clearly* indicate where "J" data make a significant contribution to risk estimates.

Indicator Chemicals:

Grouping of related contaminants for representation in the risk assessment as single Indicator Compound (IC) is appropriate for chemicals with similar toxicity and/or properties related to environmental fate and transport (e.g., persistence, volatility, migration potential, etc.). The compound chosen to represent the group should represent a "worst case" decision (i.e., should be the most toxic, most persistent, etc. member of the group; according to whatever property is most appropriate to the situation).

When using this approach, the concentration of the Indicator Compound used in the exposure assessment should be set at a level equal to the sum of the individual contaminants in its group. Since the Indicator Compound concentration is set equal to the sum of the concentrations of all individual contaminants in its group, this procedure does not eliminate the contribution of any contaminants to the risk estimate.

Screening of Group A Carcinogens:

In general, Group A compounds, Known Human Carcinogens, should not be screened out from the quantitative risk assessment. This recommendation is regardless of the selection criteria used to exclude other chemicals (e.g., frequency of detection, comparison to back-

ground, etc.). If there is a strong rationale for elimination of a Group A compound, consultation should be sought with the site manager and the Department's Toxicologist.

Units of Concentration:

Careful attention should be given to expressing contaminant concentrations in the correct units of measurement in the site investigation and risk assessment reports. The risk assessor should ensure that laboratory results are being communicated to him or her in the correct units of measurement (e.g., 1 part-per-**billi**o**n** (pp**b**) of dioxin in soil may not be of concern to the Department, 1 part-per-**milli**o**n** (pp**m**) certainly is of concern).

Common Laboratory Contaminants:

U.S. EPA considers the following chemicals to be common laboratory contaminants. Detection of these chemicals in samples from the remedial investigation may not be indicative of their presence as contaminants at a site:

- Acetone
- 2-butanone
- Methylene Chloride
- Toluene
- Phthalate Esters

Detection of these chemicals in samples from a site under investigation should only be considered "positive" results (indicative of contamination) *only* when their reported concentrations are greater than 10 times the maximum amount detected in any blank sample from the site investigation.

Blank Sample Contamination:

Concentrations of any chemicals not considered "common laboratory contaminants" by EPA should be considered "positive" results only when their reported concentrations are greater than 5 times the maximum amount detected in any blank sample from the site investigation. Any results showing levels less than 5 times the maximum blank concentration are to be treated as "non-detects" (with the concentration detected in the blank as the quantitation limit for that chemical).

Tentatively Identified Compounds:

In general, tentatively identified compounds (TICs) should not be factored into a risk assessment. However, if there is good reason to suspect that such chemicals may be present as contaminants at the site, further investigation of TICs may be necessary.

Normal versus Log-Normal Contaminant Distribution:

EPA's Risk Assessment Guidance for Superfund (RAGS section 6.4.1) states that exposure scenarios should be based on the arithmetic mean of the reported concentrations of contaminants at the site; this assumes that contamination is normally distributed at the site. Use of statistical measures based on the assumption of normal distribution is the default condition for human health risk assessments submitted to the Department. Under this condition, the following concentration terms should be used in the exposure assessment:

- The mean contaminant level is used as the concentration term in a Central Tendency exposure and risk estimates.
- The 95% upper confidence limit of the mean contaminant level is used as the concentration term in the High End exposure and risk estimates.

There is debate in the scientific community over whether environmental contamination is best summarized by arithmetic or geometric means (i.e., whether contamination is usually distributed normally or log-normally in the environment). For a particular site, the Department may consider the use of statistical expressions based on log-normal distribution, provided:

- data on contaminants at the site were collected in an unbiased fashion (see **Purposive vs. Random Sampling**, above), and
- an appropriate statistical analysis is presented which indicates the contaminant levels are best described by a log-normal distribution.

Section 4: EXPOSURE ASSESSMENT

Exposures

Superfund exposure assessments may consider past, present and future exposures. Current and past scenarios should be based on actual exposure conditions, future scenarios on potential exposure conditions. Typically, Superfund risk assessments focus on current and future exposures, but past exposures may be important for selected sites; ATSDR should take the lead in evaluating any current health effects from past exposures.

Potential Exposure Pathways

All potential exposure pathways should be discussed. Those that clearly present no risk because they are incomplete or irrelevant can be dismissed after being acknowledged; the rationale for elimination of a pathway must be documented.

Complete Exposure Pathways

Risks should be assessed ONLY for exposure pathways which are complete; i.e. those that consist of:

- a source and mechanism for release of contamination
- a transport medium
- a point of potential human contact with the contaminated medium
- an exposure route at the point of human contact

Note that a medium, such as soil, that became contaminated by a chemical release in the past may serve as a source of contamination for another medium, such as groundwater.

It may not be possible to quantitatively assess some of the complete pathways at a site. This situation should be clearly discussed in the risk characterization and summary sections of the risk assessment, with special attention paid to its contributions to uncertainty in the risk assessment.

Reasonable Maximum Exposure Scenario - Total Site Exposure

The overall risk estimate for a site, integrated over multiple pathways and chemicals, is expected to represent a "reasonable maximum exposure" (RME) scenario. In most cases, this will require estimation of both average and reasonable maximum exposure scenarios/risks for each pathway.

Professional judgement will be required to determine which combination of average and reasonable maximum pathways represents a reasonable maximum exposure for the overall site-related contamination. In many cases the overall site RME will include one pathway-specific RME scenario in conjunction with average scenarios for most or all other pathways (RAGS _ 6.7).

Average Exposure Scenario - Pathway

For the pathway-specific Average scenario, intake variables should be set to represent the most likely or average exposure conditions.

Specific suggestions include:

- mean contaminant levels
- mean values for contact/intake variables such as:
- exposure frequency
- exposure duration

Reasonable Maximum Exposure Scenario - Pathway

For the pathway-specific RME, intake variables for a given pathway should be set so that the combination of intake variables represents a reasonable maximum set of exposure conditions.

Specific suggestions include:

- upper 95% confidence limit of the mean contaminant level
- 90-95% percentile values for contact/intake variables such as:
 - exposure frequency
 - exposure duration

Mean body weights are to be used for RME scenarios.

In establishing the exposure assumptions for a "reasonable maximum exposure" the risk assessor must be careful that it not become a de facto worst-case scenario.

Exposure Factors Handbook

In general, exposure assumptions in the Exposure Factors Handbook (EPA/600/8-89/043) should be used for Department of Health risk assessments. Site-specific data may be substituted when they are available and reliable.

Some specific exceptions to this recommendation exist; see **Water Ingestion/Air Inhalation** and **Soil Ingestion** comments in this section.

Water Ingestion/Air Inhalation

The traditional "default" values of 2 liters/day water ingestion and 20 m³/day air inhalation should be used for both "Average" and "Reasonable Maximum" scenarios in Department of Health risk assessments. This deserves special notice since the general guidance is to use intake assumptions from the Exposure Factors Handbook, which presents different average values.

Use of the traditional values is necessitated by the fact that many EPA risk assessment "standards" were based on those intake values (e.g. RfDs, MCLs). It is the opinion of the Department of Health Toxicology Group that these traditional values represent "reasonable maximum exposure" assumptions and are therefore appropriate under RAGS.

- Drinking water ingestion = 2 liters/day
- Air inhalation = 20 m³/day

Soil Ingestion

The soil ingestion rates currently recommended for use in Superfund risk assessments are (OSWER Directive 9850.4):

- 200 mg/d for children 1-6 years of age
- 100 mg/d for others

Note that household dust, which contributes significantly to daily soil ingestion, may have contaminant concentrations equal to 75-80% (Hawley: Risk Analysis 5:289, 1985) to 100% (RAGS) of outdoor soil. Thus for some scenarios, exposure may occur for 24 hours/day even though "outdoors" time is only a fraction of the day.

Future Land Use

Often, the most appropriate future land use scenario is Residential Development; if so, the risk assessment should address the corresponding potential risks. Many areas in Hawai'i are experiencing dramatic population growth which creates pressure to develop areas previously considered inappropriate or unlikely for residential use.

However, this scenario is not always justified and should not be used at those sites where residential development is highly unlikely. Land uses in the surrounding areas, zoning regulations and master development plans should be consulted to determine the likelihood of future residential development.

Residential Exposure Duration

New default values for duration of residential exposures are established by the Exposure Factors Handbook (EPA/600/8-89/043):

| | |
|-------------------|----------|
| Average duration: | 9 years |
| Maximum duration: | 30 years |

The latter is recommended for RME scenarios; site-specific data may be used where available.

Exposure Averaging Time - Carcinogenicity, Chronic Toxicity

Exposures relating to carcinogenicity and chronic toxicity are assessed using cancer risk slope factors (SFs) and reference doses (RfDs), respectively. These toxicity criteria are applicable to long-term exposures, those expected to occur for more than seven years.

Exposure Averaging Time - Subchronic Toxicity

Exposures relating to subchronic toxicity are assessed using subchronic reference doses (RfD_s in RAGS, alternatively sRfDs). These toxicity criteria are applicable to exposures expected to occur for two weeks to seven years.

Exposure Averaging Time - Developmental Toxicity

Exposures relating to developmental toxicity are assessed using developmental toxicity reference doses (RfD_{dt}s in RAGS, alternatively dtRfDs). These toxicity criteria are applicable to single event exposures.

Less-Than-Lifetime Exposures

For carcinogens, chronic daily intakes are determined by prorating the total cumulative dose over a lifetime. Appropriate equations for this are presented in Chapter 6 of RAGS.

This approach is based on the Agency's assumption for carcinogens that a high dose received over a short period of time is equivalent to a corresponding low dose received over a lifetime (Guidelines for Carcinogen Risk Assessment, 51 FR 34042, 24 September 1986).

This assumption may not be valid for high-level, short-term exposures to some carcinogens, notable possible exceptions include vinyl chloride and asbestos. If either of these is present at a site, consult the Department of Health's Toxicology Group.

Exposure to Volatile Organics While Showering

Two methods are available for assessing the exposure to volatile organic compounds (VOCs) while showering. The RAGS manual presents an equation for estimating inhalation exposures to vapors (exhibit 6-16) in general and suggests some specific values for inhalation rate and duration of exposure while showering. To use this equation, estimates of airborne contaminant levels within the shower and bathroom will have to be developed by the risk assessor.

Hawai'i Department of Health will also accept a generic model discussed by EPA's Risk Assessment Forum in a draft guidance on this subject. The model assumes that the dose from inhalation of VOCs while showering is approximately equivalent to the dose from ingestion of 2 liters/day of the same water. (Note that the risk should be assessed using inhalation-specific toxicity criteria (SFs, RfDs).)

Trespasser Scenario

A "trespasser" scenario should be used only at those sites where such activity is known or is likely to occur to a significant degree (e.g., an uncontrolled rural site known to be fre-

quented by off-road vehicles). When used, it should represent realistic estimates of actual exposures.

Documentation

All exposure assumptions should be documented. This is especially important for assumptions that are site-specific or differ significantly from the standard of practice for risk assessment.

Worst Case Scenarios

Worst case exposure scenarios are generally not to be used for other than screening purposes. Typical assumptions leading to a worst case scenario are continual 24 hour-per-day exposures for a complete 70 year lifetime. It is generally not appropriate to use a worst case scenario to justify remediation or to set clean up levels.

A worst case scenario is appropriate for eliminating those exposure pathways which clearly do not present a significant risk. If worst case assumptions are used and the analysis indicates a *de minimus* risk (typically less than a 1×10^{-6} upperbound estimate of excess lifetime cancer risk), then the relevant exposure may usually be eliminated from further consideration. (An exception might be where multiple exposure pathways exist, all or most with risk estimates close to 10^{-6} ; if enough pathways exist, the aggregate risk may be significant even though each individual pathway risk is *de minimus*.)

Hotspots

A hotspot is a relatively small area which is highly contaminated. Often this is the location of a discrete chemical leak or limited usage area. The existence of hotspots usually must be identified by someone with an intimate knowledge of the site, its history of contamination and the remedial investigation data.

Contamination levels at a hotspot should not be "diluted out" by inclusion of $1/2$ limit of detection values from surrounding cleaner areas. Professional judgement should be employed in deciding which samples are used to define the hotspot.

Consideration should be given to separate assessment of the potential risk from a hotspot. Chronic exposures at the location of a hotspot are often unlikely; however, the levels of contamination may be sufficient to produce acute or subchronic toxicity. Again, professional judgement will have to be exercised in deciding how to assess this risk potential.

The manual suggests that "averaging soil data over an area the size of a residential backyard ... may be most appropriate for evaluating residential soil pathways" (RAGS _ 6.5.3).

This approach may be appropriate for assessing risk at some hotspots.

Absorption Factors

Absorption factors should not be used to modify exposure estimates in those cases where absorption is inherently factored into the toxicity/risk parameter, such as cancer risk slope factors (SFs) or reference doses (RfDs).

Most SFs and RfDs are derived from experiments/studies based on **applied** dose; "correction" for fractional absorption is appropriate only for those values derived from experiments/studies based on **absorbed** dose. For example, cancer risk slope factors, unit cancer risks or reference doses are usually developed from laboratory animal studies which, by their nature, are already influenced by any effect of absorption fraction. Therefore no "correction" due to incomplete absorption is appropriate when these standards are used.

Correction for fractional absorption is appropriate in two cases:

- 1) Interaction with environmental media or other contaminants may alter absorption from that expected for the pure compound (e.g., organic compounds often bind to soil, thus reducing their bioavailability).
- 2) Assessment of exposure via a different route of contact from what was utilized in the experimental studies establishing the SFs and RfDs (e.g., dermal contact requires estimation of an absorbed dose since few, if any, dermal SFs or RfDs exist and absorption across the skin can be considerably less than by ingestion or inhalation).

Dermal Exposure

Specific equations are presented in exhibits 6-13 and 6-15 for assessing dermal exposure to chemicals in water and soil. Some points about these equations should be underscored:

The area of skin surface available for contact should be based on 50th percentile distributions for both average and reasonable maximum exposure scenarios.

As noted in RAGS, the permeability constant values listed in the Superfund Exposure Assessment Manual (OSWER Directive 9285.5-1, EPA/540/1-88/001) are "currently being reviewed and should not be used at this time." The toxicological and medical literature should be consulted for compound-specific values. One useful source is Loomis TA: "Skin as a Portal of Entry for Systemic Effects" in Current Concepts in Cutaneous Toxicity, edited by Drill VA and Lazar MD, Academic Press (New York), 1980.

EPA's Environmental Criteria and Assessment Office (ECAO) is another source of technical guidance on assessment of dermal exposures. ECAO can be reached at (513) 569-7300.

TOXICITY ASSESSMENT

There are two main components to toxicity assessment: hazard identification and dose-response evaluation. Neither of these is typically performed in a site-specific risk assessment; a typical risk assessment utilizes the results of these analyses performed by others, usually from EPA HQ.

A hazard identification determines what type(s) of toxicity a particular chemical is capable of causing. Usually, the most important consideration is whether the chemical can cause cancer.

A dose-response evaluation defines the conditions (i.e., routes and levels of exposure) required for the chemical to cause the toxicities determined in the hazard identification.

Hierarchy of Toxicity Information Sources

The following sources should be consulted, in the order presented below, for toxicity information on contaminants at Superfund sites:

1) *IRIS: Integrated Risk Information System*

IRIS is the consensus risk database for all EPA programs; all of the reference dose and cancer slope factor values in IRIS have been verified by either the RfD or CRAVE Workgroups. It supersedes all other sources of toxicity information for risk assessment. The toxicity summaries in IRIS should not be considered an extensive review of the literature, they address only specific risk-related aspects of a chemical's toxicity. They do, however, provide some of the information on critical organ-specific toxicity needed for segregating hazard index values when the overall HI exceeds unity.

For information on using IRIS, contact User Support:
(513) 569-7254.

2) *HEAST: Health Effects Assessment Summary Tables*

HEAST summarizes risk-related toxicity information from the following EPA documents:

- Health Effects Assessments (HEAs)
- Health and Environmental Effects Documents (HEEDs)
- Health and Environmental Effects Profiles (HEEPs)
- Health Assessment Documents (HADs)

Ambient Air Quality Criteria Documents (AAQCDs)

HEAST provides even less toxicity information than does IRIS. HEAST can be obtained by contacting:

Superfund Docket: (202) 382-3046

EPA Center for Environmental Research Info: (513) 569-7562

Natl Technical Information Service: (800) 336-4700.

3) EPA Criteria Documents

EPA criteria documents are issued by program offices and include:

Drinking Water Criteria documents

Drinking Water Health Advisory summaries

Ambient Water Quality Criteria documents

Air Quality Criteria documents.

Some of these contain toxicity summaries or literature reviews that are more extensive than those in IRIS; they may be of use in identifying organ-specific toxicities. Criteria documents are available from NTIS (see above).

4) ATSDR Toxicity Profiles

ATSDR profiles are relatively thorough reviews of the toxicity information on specific common contaminants at Superfund sites. In general, they are not a source of information of toxicity values for quantitative risk estimation.

ATSDR profiles can be obtained through NTIS (see above).

5) Environmental Criteria and Assessment Office (ECAO)

ECAO can be used for information on route-to-route extrapolation of risk assessment values, toxicity values for dermal exposure and evaluation of chemicals without standard risk assessment values.

ECAO may be contacted at (513) 569-7300.

Weight of Evidence Classifications

All discussions of compounds treated in the risk assessment as carcinogens (usually Group A, Known Human Carcinogens; Group B, Probable Human Carcinogens and Group C, Possible Human Carcinogens) should include the weight of evidence categorization for each. This is particularly important when cancer slope factors (SFs) are listed or summarized and when risk estimates are developed or discussed. The distribution of risk among the various classes of "carcinogens" must always be clearly presented to the reader.

Development of Reference Doses (RfDs)

In some cases, RfDs for one or more contaminants at a site will need to be developed by the risk assessor. This should only be undertaken after a thorough search of EPA information sources for appropriate risk assessment values and subsequent consultation with the Toxicology Group.

The general procedure to be followed is outlined in RAGS _ 7.2; the risk assessor should work with the Toxicology Group in applying these procedures.

Development of Cancer Slope Factors (SFs)

In rare situations, the risk assessor may need to develop a cancer slope factor for a contaminant at a Superfund site. This should only be attempted after a thorough search of EPA information sources and consultation with the Toxicology Group.

RISK CHARACTERIZATION

Interpretative Text

The following statement appears in the introductory paragraphs to Chapter 8, Risk Characterization, of RAGS:

"A risk characterization cannot be considered complete unless the numerical expressions of risk are accompanied by explanatory text interpreting and qualifying the results."

This concept is strongly endorsed by Hawai'i Department of Health.

Criteria for Risk Estimation - Non-cancer Toxicity

The following toxicity values are appropriate for estimating the potential risk of non-cancer toxicity. These toxicity values should be used in a hazard quotient-type of analysis; the ratio is calculated of the estimated daily intake for each chemical to one or more of the appropriate toxicity values below:

Chronic Reference Doses (RfD)

A chronic RfD is "an estimate (with uncertainty of perhaps an order of magnitude) of a daily exposure level for the human population, including sensitive sub-populations, that is likely to be without appreciable risk of deleterious effects for a lifetime of exposure" (RAGS _ 7.2). RfDs are appropriate for evaluating exposure durations between 7 years ($1/10$ of a lifetime) and an entire lifetime. RfDs that have been verified by the RfD Workgroup are listed in IRIS; other RfDs may be found in HEAST.

Sub-chronic Reference Doses

Sub-chronic reference doses (RfD_ss in RAGS, alternatively sRfDs) are toxicity criteria that are applicable to non-cancer toxicities associated with exposures expected to occur for periods of 2 weeks to 7 years. At present, none of the RfD_ss/sRfDs developed by EPA have been verified.

Developmental Reference Doses

Exposures relating to developmental toxicity are assessed using developmental toxicity reference doses (RfD_{dt}s in RAGS, alternatively dtRfDs). These toxicity criteria are applicable to single event exposures.

Health Advisories

For short-term oral exposures, non-cancer toxicity potential may also be evaluated by comparison to 1-Day or 10-Day Health Advisories. Health Advisory values are available on IRIS and in the Health Advisory criteria documents issued by the Office of Drinking Water.

Carcinogens - Non-cancer Toxicity Risk Estimation

Exposure to carcinogens should be factored into both the cancer risk estimation and hazard index calculation (i.e., non-cancer toxicity evaluation). The fact that a chemical is carcinogenic does not mean that its potential to contribute to a non-cancer toxicity risk can be ignored.

Weight of Evidence Classification

Any discussion of cancer slope factors (SFs) for specific chemicals should be accompanied by the weight of evidence classification for each chemical; for example:

Benzene, oral SF = $2.9 \times 10^{-2} \text{ (mg/kg/d)}^{-1}$ [A]

Chloroform, inhalation SF = $8.1 \times 10^{-2} \text{ (mg/kg/d)}^{-1}$ [B2].

Significant Figures - Risk Estimates

Upperbound estimates of excess lifetime cancer risk should be expressed in the risk assessment with only one significant figure. A numerical risk estimate presented as " 3.48×10^{-5} " implies a level of accuracy not currently achievable in risk assessment.

Class C Compounds

Class C compounds are those designated by EPA as "Possible Human Carcinogens". Typically they exhibit Inadequate evidence of carcinogenicity in humans and Limited

evidence in animals. There are two options available for risk estimation for Class C compounds; they may be assessed in a quantitative cancer risk fashion or a modified-RfD approach may be employed.

In a quantitative cancer risk approach, the estimated chronic daily intake is multiplied by the cancer slope factor to yield a numerical upperbound estimate of excess lifetime cancer risk. This is the same procedure used for Group A and B compounds.

In the modified-RfD approach, the estimated chronic daily intake is compared, in hazard index fashion, to an RfD that is modified to account for the carcinogenic potential of the compound. The Office of Drinking Water has developed Maximum Contaminant Level Goals (MCLGs) based on the modified-RfD approach for some of the Class C compounds.

The risk assessor should consult with the Toxicology Group regarding the which approach to use for individual Class C compounds.

Toxicity Values and Fractional Absorption

The risk assessor should ensure that the toxicity values used in risk characterization match the exposure estimates with respect to fractional absorption of the contaminant. If fractional absorption is factored into the exposure estimates, the toxicity values used to estimate risk must also be based on fractional absorption (not on applied dose).

Summation of Risk Across Chemicals in An Exposure Pathway

The exposure assessment will estimate a daily (or single-event) exposure to each individual chemical via each exposure pathway. A separate upperbound estimate of excess lifetime cancer risk should then be calculated for each carcinogen and a hazard quotient for all chemicals. A pathway-specific cancer risk estimate and hazard index are then calculated by summing the contributions of each chemical in the pathway. Where applicable, separate summations should be performed for chronic, sub-chronic, short-term and developmental toxicities.

Summation of Risk Across Exposure Pathways

As noted in the EXPOSURE ASSESSMENT section, the risk assessment should address combinations of exposure pathways that create a reasonable maximum exposure scenario. The first step is to identify those exposure pathways that have the potential to affect the same individual(s); consider the areas of highest exposure for current and future land uses. Professional judgement will have to be exercised to determine which combination of single-pathway RME and average exposures represents the best estimate of a combination RME for the entire site. RAGS _ 8.3.1 notes:

"Only if you can explain why the key RME assumptions for more than one pathway apply to the same individual or subpopulation should the RME risks for more than one pathway be combined....it may be appropriate to combine one pathway's RME risks with other pathways' risk estimates that have been derived from more typical exposure parameter values. In this way, resulting estimates of combined exposure pathway risks may better relate to RME conditions."

Again, where applicable, separate summations should be performed for chronic, sub-chronic, short-term and developmental toxicities.

Hazard Indices Greater Than Unity

When a pathway-specific or overall-site hazard index is greater than unity (i.e., $HI = \sum HQ > 1.0$; where $HQ = DI/RfD$ for each chemical, DI = daily intake), it is appropriate to segregate the individual hazard quotients on the basis of target organ or mechanism of action. Next, organ- or mechanism- specific hazard quotients are calculated and evaluated for risk potential. When employing this procedure, attention must be paid to toxicities other than the critical effect identified in IRIS. Thus it may be appropriate to sum the hazard indices for two chemicals whose critical effects are on different organs, if either's secondary toxicity is on an organ affected by the other.

A thorough understanding of the chemicals' toxicities is needed to appropriately segregate hazard quotients on an organ- or mechanism- specific basis.

Cancer Risk Summation

As noted in RAGS (_ 8.2.2), summation of upperbound estimates of excess lifetime cancer risks can introduce additional conservatism into the risk assessment (i.e., make it more likely to overestimate the actual cancer risk). This is because upper 95th percentiles of probability distributions are not strictly additive. If a large number of chemicals are included in the risk assessment as carcinogens, this additional contribution to the overall conservatism should be noted in the uncertainties discussion.

As noted below in the RISK FORMAT/REVIEW section, aggregate cancer risk estimates should be segregated on the basis of weight of evidence category. The goal is to provide a clear understanding of the risk contribution of each category of carcinogen: Group A, Known Human Carcinogens; Group B, Probable Human Carcinogens and Group C, Possible Human Carcinogens.

Individual and Population Risk Estimates

Where possible, cancer risk estimates should be expressed in terms of both individual and population risk. For the population risk, the individual upperbound estimate of excess

lifetime cancer risk for an average exposure scenario is multiplied by the size of the potentially exposed population.

As an example, a table of risks can be constructed as follows:

| Individual Risk | Size of the Exposed Population | Population Risk |
|----------------------------|---|----------------------------|
| 10^{-4} | 150 people | 0.015 |
| 10^{-5} | 2600 people | 0.026 |
| 10^{-6} | 30,000 people | 0.03 |

REPORT FORMAT/REVIEW

Site History

The description of the site should include the following:

A detailed map or maps showing the site relative to surrounding structures, terrain features and an indication of air/water flows. The scale of the map should be such that most or all impacted areas are presented.

A detailed map or maps of the site itself showing the locations of the facility's operations and units (both past and present). Details about the areas of contamination should also be included.

A description of the industrial processes operative at the site (both past and present). This should include a discussion of the length of time each process was/is in operation and the potential for leakage and other contamination events.

Toxicity Summaries

A short summary of the toxicity of each site contaminant should be included in the risk assessment. This summary should be understandable to the lay reader and should present a balanced view of scientific opinion. For example, it would be appropriate in a summary of arsenic toxicity to note that it is considered both a carcinogen in humans and an essential nutrient. A balanced presentation is especially important for compounds with equivocal interpretations of carcinogenicity or toxicity.

In general it is not necessary to include a detailed scientific review of the toxicity literature in the risk assessment. The ATSDR Toxicity Profiles or appropriate articles in the medical/biological literature can be cited for detailed toxicity reviews. However, if an RfD or a SF was developed for a particular compound, a detailed review of that procedure and the supporting literature should be presented in the risk assessment report.

Units of Concentration

Consistent units of measurement should be used in expressing chemical concentrations. Where two different units are in common use, consider presenting values in both units (i.e., "Benzene was detected at 2.3 ppb [6.9 µg/m³]"). At a minimum, the appropriate conversion factors should be specified for each chemical in the chemical properties section.

Cancer Risk Qualifier

Cancer risk estimates should be presented and discussed with language describing the uncertainty and estimation inherent in their derivation. As noted in the EPA Guidelines for Cancer Risk Assessment (51 FR 33992, 24 September 1986): "The range of risks, defined by the upper limit given by the chosen model, *and the lower limit, which may be as low as zero, should be explicitly stated.*" A suggested format for such a statement:

"These values are upperbound estimates of excess cancer risk potentially arising from lifetime exposure to the chemical in question. A number of assumptions have been made in the derivation of these values, many of which are likely to overestimate exposure and toxicity. The actual incidence of cancer is likely to be lower than these estimates and may be zero."

Such a risk statement should be able to stand alone (out of context) without losing the feeling for conservatism in the estimate.

Remediation Goals

The Hawaii Department of Health's remediation objective is for remedies that reduce ambient chemical concentrations to levels associated with a carcinogenic risk range of

10⁻⁴ to 10⁻⁶, where possible. The risk assessor should not anticipate Department of Health's decision about a specific risk goal at a particular site; if reference needs to be made to Department of Health goals, the range should be stated.

Summary Tables

The risk assessment should contain summary tables on the following:

Cancer risk estimates and hazard indices for both average and reasonable maximum exposure scenarios for each pathway and for an aggregate RME scenario for the entire site. Prior to summation of the aggregate risk, estimated cancer risks should be segregated by weight of evidence category for the contaminants at the site.

These tables should include comments highlighting any unusual factors that may influence interpretation of the risk estimates (such as: "Risk primarily due to assumed drinking water use of a non-potable aquifer." or "Metals at levels below background contribute significantly to the estimated risk." or "Risk primarily due to X, which is present at levels below its MCL.").

Exposure assumptions for each scenario, with documentation of source or rationale for use (see exhibit 6-20 for an example of a table summarizing exposure assumptions).

Exposure estimates (estimated daily intakes) with comments on the major contributing factors

Reference dose (RfD) and cancer slope factor (SF) values (and any other toxicology criteria used in the risk assessment). SFs and estimates of the upperbound excess lifetime cancer risk should be accompanied by the weight of evidence appraisal for each chemical.

Contaminant levels at the site (include mean, upper 95% confidence limit of the mean, maximum, # detected/# samples).

Attached are some example tables illustrating some of these preferred features (note the format, not necessarily the exposure assumptions).

Tables should contain sufficient information that they can stand alone (i.e., without accompanying text).

Uncertainty

To the extent they are known, the report should clearly identify which site-specific vari-

ables and assumptions contribute most to the uncertainty in the risk assessment. If possible, an estimate of the magnitude and direction (i.e., increase or decrease conservatism) should be discussed.

Summary Risk Discussion

The following elements should be included in the summary discussion of the risk assessment:

Level of confidence that the key site-related contaminants were identified and included in the risk estimates.

Discussion of contaminant concentrations relative background levels.

Description of the various types of health risks present at the site; it is important to distinguish between those known to occur in humans and those predicted to occur based on experiments in animals.

Level of confidence in the toxicity information used to estimate risks.

Discussion of qualitative information on the toxicity of substances not included in the quantitative risk assessment.

Level of confidence in the exposure estimates for key exposure pathways

Magnitude of the upperbound estimates of excess lifetime cancer risk relative to the Department's remediation goals set forth in the National Contingency Plan (i.e., the carcinogenic risk range of 10^{-4} to 10^{-6} and non-cancer toxicity hazard index of 1.0).

Major factors contributing to overall site risk estimates.

Major factors contributing to uncertainty in the site risk estimates.

The discussions of level of confidence should include an indication of whether the assumptions used are likely to over- or under- estimate actual risks.

Dated Material

All correspondence and documents (as well as any attachments, etc. that may become separated) should be clearly dated.

SUMMARY

Early involvement of the risk assessors is the most important of these recommendations. Most problems with risk assessment arise at the interface between the remedial investigation data and the risk assessment. It is crucial that appropriate data be collected in the remedial investigation and that these data be used correctly in the risk assessment..

EPA is increasingly relying on risk as an important determinant in making remediation decisions. The quality of the risk assessment process can be dramatically improved if the risk assessors are an integral part of the entire project.

The next most important recommendations are adequate characterization of current and background exposures and their associated risks. These are often completely overlooked or poorly studied in the remedial investigation, yet can have a major impact on the potential risk associated with a site.

RISK ASSESSMENT GUIDELINES FOR HUMAN HEALTH RISK ASSESSMENT

REFERENCES:

National Oil and Hazardous Substance Contingency Plan, 40 CFR 300, Final Rule 3/8/90.

Habicht H: Guidance on Risk Characterization for Risk Assessors and Risk Managers. EPA policy memorandum, 26 February 1992.

U.S. EPA: Exposure Factors Handbook. Office of Health and Environmental Assessment (OHEA), EPA600/8-89/043.

U.S. EPA: Risk Assessment Guidance for Superfund. Volume 1, Human Health Evaluation Manual (Part A). EPA/501/1-89/002.

Integrated Risk Information System (IRIS)

Section 6

RESPONSE ACTION MEMORANDUM

Section 6

Response Action Memorandum

6.1 Introduction and Purpose

The Response Action Memorandum (RAM) describes the Hazard Evaluation and Emergency Response (HEER) Office's decisions regarding the response action selected for cleaning up a site.

Prior to issuing a RAM, the HEER Office prepares a draft RAM. In some situations, the HEER Office may ask the potentially responsible party (PRP) to gather information and write the initial draft RAM. However, a PRP is only asked to write a draft RAM when a formal agreement has been negotiated and the HEER Office has determined a cooperative effort would be advantageous to the particular case in question. Each RAM must go through public comment before it can be finalized. The department will issue a final RAM after consideration of all public comment received on the draft RAM.

The RAM is written to clearly identify the response action that will be performed in response to the release of a hazardous substance which poses an actual or potential risk to human health, the environment or natural resources. Response actions proposed in the draft RAM are based on information contained in the administrative record, including the remedial investigation and feasibility study. Construction of the selected remedy may not be initiated until the final RAM has been completed, approved and issued.

Changes to a response alternative proposed in the draft RAM may be made by the HEER Office when comments or data indicate a more appropriate cleanup solution should be selected. After comments are considered by the HEER Office, the final decision regarding the selected response activities is documented in the final RAM.

6.2 Description

The RAM summarizes the information compiled about a site including: 1) Scope and Background; 2) Site Risks; 3) Cleanup Strategy; 4) Criteria and Evaluation of Alternatives; and 5) Proposed Remedy. The content and level of detail of each RAM will vary depending on the scope of the response action.

6.2.1 Scope and Background

The RAM summarizes and describes how the preferred response alternative meets the Department of Health's overall cleanup strategy based on the cleanup criteria necessary to address the threat to human health, the environment or natural resources.

The RAM includes background information about the site including: a site map, a brief description of the site, past and present owners; including the history of waste generation; waste disposal; contaminants of concern; contaminated media; and the extent of contamination.

6.2.2 Site Risks

The RAM summarizes the extent of contamination and presents the risks using information derived through remedial investigation. Site risks include key findings which indicate actual or potential risk to human health, the environment or natural resources as they pertain to:

- Contaminated media.
- Contaminants of concern.
- Routes of exposure i.e., groundwater, surface water, soil or air.
- Environmental risks such as ecological receptors, potential exposures, and potential effects of exposure for constituents with no Department of Health standards.
- Current risks compared to current acceptable cleanup levels.

During the development of response alternatives, the HEER Office will use the most current established cleanup levels to insure protection of public health, the environment, or natural resources as follows:

- For systemic toxicants, acceptable cleanup levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety.
- For known or suspected carcinogens, acceptable cleanup levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response. The 10^{-6} risk level shall be used as the point of

departure for determining acceptable cleanup levels for alternatives when chemical specific state or federal requirements are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure.

6.2.3 Cleanup Strategy

The RAM provides a brief narrative of the cleanup strategy selected. The cleanup strategy specifies the treatment technology(ies), engineering controls, institutional controls, quantities of waste handled, implementation requirements, and the estimated implementation time frame associated with each response action. In addition, the major applicable requirements (ARs) associated with the cleanup strategy are discussed.

6.2.4 Criteria and Evaluation of Alternatives

The RAM identifies the preferred and alternative response actions and the criteria used in the evaluation. The criteria is used to profile the performance of the preferred response action by comparing the preferred response action to other proposed alternatives. The criteria and detailed analysis used to evaluate the overall feasibility and acceptability of response alternatives includes:

Effectiveness - The effectiveness criterion considers reduction of toxicity, mobility, or volume through treatment; minimization of residual risks; long-term reliability; minimization of short-term impacts and how quickly it achieves protection.

Implementability - The implementability criterion focuses on the technical and administrative feasibility of implementing the alternative. In addition the implementability criterion considers the level of community acceptance of the remedial action.

Cost - The cost criterion considers the cost of constructing the response action and the operation and maintenance costs.

6.2.5 Proposed Remedy

Based on available information, the HEER Office selects a proposed remedy. The remedy selection is based on a analysis of each proposed alternative in relation to three criteria: 1)Effectiveness, 2) Implementability, and 3) Cost.

The proposed response alternative must provide the best balance of tradeoffs among the alternatives and the evaluation criteria considering how the response action fits into

the overall site clean-up strategy and how the selected response action addresses the principal threat(s) posed by the release.

6.3 RAM Changes

The HEER Office will encourage the public to submit comments and will inform the public that their comments can influence the response action selection process. The HEER Office will consider all relevant comments and any new and significant information which may change a component of the selected response action or require the implementation of another response action alternative.

When determining whether or not a change to a proposed remedy is necessary and appropriate, typically the HEER Office will assess the following:

IMPACT: Changes that alter the selected response activities based on new information related to the impact on overall protection of human health, the environment or natural resources.

COMPLIANCE: Changes made to the selected response in order to comply with applicable requirements.

EFFECTIVENESS: Changes that alter the selected alternative in order to address a release of a substantially greater or lesser volume of waste, a new environmental pathway, or a substantially greater physical area of the site.

IMPLEMENTABILITY: Changes in treatment technologies or processes that significantly alter the long-term effectiveness of the remedy or that have significantly different short-term effects.

COST: Changes made to the selected response based on discovery of less costly cleanup alternatives that become available after the appropriate response action was selected, which treat a particular hazardous release site at least equally as well as the response action originally selected.

6.4 The Responsiveness Summary

The Responsiveness Summary is the final section in the RAM. The Responsiveness Summary addresses all relevant public comments.

The Responsiveness Summary serves several purposes. First, the Responsiveness Summary provides the decision makers with information about community preferences regarding both response action alternatives and general concerns about the source of hazardous waste release. Second, it demonstrates how public comments (if any), were

integrated into the decision-making process. Third, it allows for response to comments "on the record". This means that a court reviewing the response action will look to see whether the HEER Office has provided a reasonable response to public comments.

The Responsiveness Summary is a concise and complete summary of all significant comments received during the public comment period. The HEER Office is responsible for writing clear, accurate, and carefully written responses to significant comments which are then included in the RAM's Responsiveness Summary.

Section 7

RESPONSE ACTION DESIGN, CONSTRUCTION & IMPLEMENTATION

Section 7

Response Action Design, Construction, and Implementation

The purpose of this section is to provide general background information for the implementation phase State Contingency Plan (SCP) process. Since very few of the sites complying with 128D are currently in this phase of the process, this Section is provided as a comprehensive overview of the response action design, construction and implementation. The DOH should consider each of the following issues and build them into the response action design, construction and implementation of a project. A Response Action Design, Construction and Implementation Work Plan should be developed which also includes a detailed implementation schedule. Smaller projects should be able to condense and simplify these requirements considerably.

7.1 Regulatory Coordination

It is common for many agencies to have jurisdiction for various aspects of a similar site. The involvement of these agencies not typically included in the earlier phases of an environmental response action may cause significant delays if not included early enough in the process. It is important to consider all possible organizations who may affect the response design and implementation or threaten its timely completion. Agencies to be considered may include the following:

- Federal Agencies (e.g., National Oceanic and Atmospheric Administration (NOAA), natural resources trustees, Housing and Urban Development (HUD));
- Local Planning Commissions;
- Zoning Authorities;
- County or city building and safety departments;
- Local water and wastewater authorities;
- Local emergency planning and response units;
- Public Utilities (gas, electric, water, telephone);
- Traffic and highway authorities;
- Other state environmental offices.

7.2 Real Estate and Access Issues

An assessment of the real estate issues in the form of a Real Estate Planning Report (REPR) should be developed. The REPR, or similar, will provide information on real estate properties or easements that may be acquired or from which residents must be relocated before the response action proceeds. Real estate information includes data on estimated acreage, number of owners and their names, property values, problems, and the need for temporary relocation of affected residents or businesses. Make arrangements for completion of the assessment before preparing the preliminary design.

Any restrictions or special agreements made with other agencies or property owners should be included. Special agreements might include requirements such as the following:

- Limiting the use of a primary access road to certain times of the day to minimize disruption of local traffic.
- Limiting excessive noise and traffic congestion by using alternative transportation routes for equipment and materials.
- Strengthening a bridge so that it may provide an access route for heavy construction vehicles.
- Using or acquiring property that could affect the design or restrict construction.

7.3 Performance Standards of RAM

For all media to be addressed, (e.g., soil, ground water, air) include, if appropriate, the following information on the RAMs standards, goals, requirements, or objectives:

- Clearly defined treatment or performance standard;
- Applicable point(s) of compliance;
- Percentage or order of magnitude reduction expected from treatment;
- Best Demonstrated Available Treatments (BDATs);
- Maximum discharge levels to be attained throughout the plume/soil matrix, at property boundaries, or at the point of release into surface water or air;

- Specific types of analyses that will be used to document achievement of required reductions;
- Criteria for disposal of treated materials;

7.4 Health and Safety Concerns

The management of the Health and Safety Program will affect completion of the project. A Site Health and Safety Plan (HSP) must be developed, or amended, for each phase of the project which considers the protection of the workers and the neighboring community. References should be made to any potential for off-site migration of toxic vapors or particulates that may result from response activities. Potential for fire and explosion should also be addressed. Associated controls, such as dust suppression, may be required to minimize health risks. Additionally, ambient air monitoring may be required at the site perimeter to determine the need for additional measures.

The use of Level A or B Personal Protective Equipment (PPE) can affect productivity and, subsequently, the schedule. Furthermore, there may be periods during the year when factors such as harmful air emissions or storm water run off contamination make construction more difficult.

7.5 Design Documentation

The HEER Office suggests that design documentation be submitted as three (or more) distinct submittals; The Conceptual Design, The Intermediate Design, and the Prefinal/Final Design. These three submittals will replace the previous submittal by providing updated information from the previous submittal.

7.5.1 Conceptual Design (10%)

This phase of the process commences with the project kick off meeting and concludes with the completion of the preliminary drawings and specifications. The decisions made during this phase of the project will set the pattern and direction of the entire design effort. During this phase, the design contractors will be collecting any additional data needed for the design, conducting any additional treatability studies, and establishing the framework for the remedial design. The major elements include the Design Criteria Analysis, the Basis of Design Report, and the Preliminary Drawings and Specifications. An outline of components is as follows:

Design Criteria Analysis

Technical Parameters (Waste Characterization, Pre-treatment requirements,

Volumes and types of media, treatment schemes, input/output flow rates, performance standards, ARs, Other technical factors important to the design.

Basis of Design Report

Design Assumptions (calculations to support the assumptions, draft process flow diagram, detailed evaluation of how ARs will be met)

Contracting Strategy (procurement method including rationale)

Permits Plan (identify all permits needed, time requirements for obtaining permits, schedule for permit application submittals)

Easements/Access Requirements

Preliminary Drawings and Specifications

Outline of General Specifications

Drawings and Schematics

Schedule for Implementation

7.5.2 Intermediate Design (60%)

The Intermediate Design phase commences at the completion of the Preliminary Design and ends with the completion of approximately 60% of the design effort. During this time, there is a continuation and expansion of the preliminary drawings and specifications. At this point, all data collection should be completed. Intermediate Design components include the following: Revised Design Criteria Analysis, Revised Basis of Design Report, and Intermediate Drawings and Specifications. The Intermediate Drawings and Specifications should include the following:

Preliminary Specifications: Detailed specifications for construction installation, site preparation, and field work standards including an equipment start up and operation training plan.

Drawings and Schematics: The drawings will be an expanded version of those submitted as part of the Preliminary Design. The type and number of drawings are dependant on the response action. The drawings should include but not be limited to:

An outline or listing of drawings

Facility representations, Process Flow Diagram

Final Piping and Instrumentation Diagram with equipment lists
Control Logic Table
Utilities Drawing
Site Plots, Existing Site Plan, Contour Maps and Physical Features
Site Work Zones
Flood Protection Plan, Excavation Plan, Site Clearing and Work Limits

Response Action Cost Estimates: The cost estimates should be accurate to plus 30 percent and minus 15 percent for simple projects and plus 40 percent and minus 20 percent for complex projects.

Updated Schedule: The schedule should identify the timing for initiation and completion of all critical path tasks. The schedule must specify the duration for completion of the project and major milestones.

Operation and Maintenance Description and Cost Estimate: As the design is refined, the actual O&M requirements become more established. This information must be presented as more information becomes available.

Unit Price List for the Response Action: The unit price for each bid item should be listed.

Chemical and Geotechnical Data: All data used to develop the design should be included in the contract documents, presented in tabular format. Sources of all data collection and any uncertainties must be identified.

7.5.3 Prefinal/Final Design (100%)

The Prefinal Design is the draft version of the completed package of drawings and specifications. At this point in the process, all design work should be completed and the contract documents prepared. Comments generated during the Intermediate Design review should be incorporated. The Final Design must be signed by a Registered Professional Engineer. The Prefinal/Final Design is comprised of the following documents:

- Complete Specifications
- Complete Drawings and Schematics

Listing of All Drawings
Facility representations, Process Flow Diagram, Floor Plans
Piping and Instrumentation Diagram
Control Logic Table

Utilities Drawing
Grading and Drainage Controls
Landscape Plan
Seeding and Sodding Plan, Wetlands and Revegetation Plan
Vicinity Map
Site Characteristics, Contour Maps, Physical Features
Site Work Zones, designating safety zones, Site Clearing Activities
Excavation Plans
Site Plats
Flood Control Plans

- Response Action Cost Estimates
- Response Action Schedule
- Design Criteria Analysis/Basis of Design Report
- Complete Contract Documents
- Construction Quality Assurance Plan
- Draft Operation and Maintenance Manual

7.6 Construction Management

The performance of the construction is the sole responsibility of the constructor. The constructor will determine the methods and sequence for the work. Prior to mobilization, the constructor will have submitted for approval a detailed schedule for how the work will be accomplished. Thus, it will be their own detailed schedule against which progress will be measured. The responsibilities of the constructor will be carried out by the Construction Superintendent. This individual will administer and coordinate the arrival of materials, equipment, and labor in a manner that proceeds without interruption. The superintendent will supervise the various foreman who are responsible for different categories of work and will administer all subcontracts.

The constructor is required to maintain an inspection system to substantiate that the work conforms with the contract requirements. The constructor must demonstrate that the work conforms with the contract before the work can be accepted by the contracting party. Inspections should be conducted on the following aspects of the project:

- Progress
- Materials
- Workmanship
- Adherence to the Design
- Health and Safety

The inspections should review all daily reports and construction activities to verify that work is in conformance with the contract. This includes confirmatory sampling of any data collected by the constructor. All data to conform that final clean up levels have been established, must also be verified. In addition, the inspector should verify compliance with all environmental requirements of the contract. These inspections shall include, but not be limited to, air quality and emissions monitoring records, waste disposal records, and a check of the health and safety procedures. There also should be a plan for regular materials testing. Both inspection reports and inspection certificates must be kept on file. Finally, the construction manager/resident engineer shall review all reports prepared by the constructor and initial each. All comments on these notes should be noted in the construction manager's daily log.

The DOH may require regular (monthly) progress reports be submitted. The progress reports will be used to monitor the construction activities. The content of these reports shall be sufficient to develop a chronological record and should contain the following information:

- Estimate of the percentage of the project complete and the total project cost to date
- Summaries of the following items for the reporting period
- Work performed on the site
- Community Relations activities which include any reports of community concerns
- Change orders and claims made on the contract
- Problems or potential problems encountered, inspection failures, reworked items
- Report of accidents, injuries, etc.
- Status of contingency funds, to date

- Projected work of the next reporting period
- Copies of daily reports, change orders, manifests for off-site disposal, and all laboratory/monitoring data

7.7 Operation and Maintenance

An Operation and Maintenance Manual for the response action shall be developed. The O&M Plan shall remain in draft form to be completed, in detail, by the construction firm that built the facility. The Manual may contain the following:

- A description of how the facility will operate.
- A description of normal operations and maintenance including start-up procedures, prescribed treatment or operation conditions, and schedule.
- A description of potential operating problems including common and/or anticipated remedies, and useful life analysis of significant components and replacement costs.
- Quality Assurance Plan for O & M, including a description of routine monitoring tasks, description of required laboratory tests, required data collection, location and rationale of monitoring points
- Alternate procedures to prevent releases or threatened releases which may endanger health or cause and exceedance of a clean up standard.
- Corrective Action to be implemented in the event of an exceedance of a clean up standard.
- Safety Plan, including a description of precautions and necessary equipment for site personnel, tasks required in the event of a system failure
- Description of equipment including the equipment identification numbers, installation monitoring components, maintenance of site equipment and replacement schedule for equipment and installed components
- Records and reporting mechanisms required including daily operating logs, laboratory records, records for operating costs, mechanisms for reporting emergencies, maintenance records, and reporting requirements to appropriate parties

- Final Operation and Maintenance Cost Estimate broken into annual projection along with the supporting documentation
- Appendices: All pertinent data used in developing the design will be included as appendices, such as calculations, chemical data, and/or geotechnical data.

Section 8

COMMUNITY RELATIONS AND PUBLIC PARTICIPATION

Section 8

Community Relations and Public Participation

8.1 General

The HEER Office is committed to involving citizens in the hazardous waste cleanup process. Our effort will be based on two-way communication designed not only to keep citizens informed about site progress, but also to give them the opportunity to provide input into site decisions. Because not every site will have a significant impact on a local community, the HEER Office will conduct its community relations efforts according

The HEER Office will encourage the participation of all interested parties in all phases

Community interviews are good sources of opinions, concerns, and expectations regarding a response action. In addition, these interviews may lead to additional information sources. Most importantly, face-to-face interviews can lay the foundation for building an open, honest, and positive relationship between the community and officials responsible for the response.

8.3 Community Relations Plan

The community relations plan is the main tool that identifies community relations needs and HEER Office activities for a given site. Community relations plans document concerns identified during community interviews and provide a detailed description of the community relations activities planned on the basis of these interviews. Community relations plans should focus on site-specific community relations techniques and approaches, not generic program goals.

The community relations plan may include:

- A description of the site background. This brief section should describe the basic historical, geographical, and technical details of the site (i.e. site location and relationship to homes, schools, history of site use and ownership).
- A history of community involvement at the site. Provide a chronology of community involvement which should identify how the community has reacted to the site in the past.
- Community relations strategies. This section describes the types of community relations activities to be conducted at the site and specifies when they should be conducted.
- A list of contacts, local officials, and interested parties. The names, addresses and telephone numbers of all officials and group representatives contacted during the community interviews, along with others who will receive information about site developments (i.e. citizen groups, state and local elected officials, responsible parties, press contacts).

The plan, if needed, should be prepared early in the process so that the HEER Office can determine the level and nature of citizen concerns.

8.4 Fact Sheets

A fact sheet is a brief report summarizing current or proposed activities of the cleanup

program. Fact sheets should present technical information in a clear and understandable format. The purpose of fact sheets is to help inform the public of the status and findings of cleanup actions and ensure that citizens understand the issues associated with the response program.

Fact sheets are appropriate whenever new information is available, and whenever a public comment period is required during the response action. Fact sheets may be mailed to interested parties or made available for distribution at or near the site. Finally, fact sheets are effective in briefly summarizing facts and issues involved in the cleanup process.

The following are types of information that may be included in a fact sheet:

- A brief background of the site;
- A timetable for the proposed actions;
- A description of the issues or problems associated with the site;
- A description of the remedial alternatives;
- A description of the public participation opportunities during the cleanup process;
- The name, address, and phone number of an agency contact person who will provide additional information on request; and
- The location of the administrative record where material is available to the public for review.

8.5 Press Releases

Press releases are statements released to the news media that discuss on-site actions proposed by the lead agency. The purpose of a press release is to make an official statement at various milestones in the response program. Examples of milestones may be at the selection of a remedial alternative, or at the completion of a containment or cleanup action.

Press releases can quickly and effectively disseminate information to large numbers of people. They may also be used to announce public meetings, report the results of public meetings, and describe how citizen concerns were considered in the response action.

8.6 Public Participation

Sections 11-451-13 (f),(g) and 11-451-15 (I), of the Hawaii Administrative Rules require the HEER Office or another party to conduct public participation activities for removal and/or remedial actions. The HEER Office's public participation activities consist of activities conducted throughout the planning and implementation of response actions to encourage communication between government staff, the local public and the potentially responsible parties at a site. The overall objectives of public participation are to:

- Provide the public the opportunity to express comments on and provide input to technical decisions. Public participation activities help local citizens contribute to decisions that will have long-term effects on their community;
- Inform the public of planned or ongoing actions. Public participation activities inform the local public of the nature of the environmental problem, the threat it may pose, the responses under consideration, and the progress being made; and
- Identify and resolve conflict. Conflict may be unavoidable in some circumstances but it can be constructive if it brings alternative viewpoints based upon sound, factual reasons into the open.

These objectives guide the planning and implementation of public participation efforts for response actions under this program. This chapter is divided into two sections: public participation in removal actions and public participation in remedial actions.

8.6.1 Public Participation in Removal Actions

This section discusses public participation requirements for removal actions. Several public participation activities are required when the HEER Office or PRPs conduct a removal action.

For removal actions conducted by the HEER Office using fund monies, the HEER Office shall conduct the following public participation activities. If the HEER Office determines that the cost of a removal action could reasonably be anticipated to exceed \$25,000; or that public participation activities are in the public interest or significant concern has been expressed or is likely to be expressed by affected or potentially affected public or private interests, including local communities, as a result of the

implementation or outcome of removal action activities, the HEER Office will conduct the following public participation activities.

1. Publish a notice of availability of the administrative record file in a newspaper.
 - The newspaper must be of general circulation in the state, and if appropriate, in a newspaper which is published at least twice weekly in the county affected by the removal action.
 - The notice shall be published within 60 days of initiation of the on-site removal activity.
 - The notice should include the proper site name and location.
2. Provide for a public comment period of not less than 30 days from the time the administrative record file is made available for public inspection.
 - In the above mentioned notice indicate that the HEER Office is soliciting public comment on the planned or ongoing removal action and the date for the public comment period.

For removal actions conducted by responsible parties, the responsible parties shall be responsible for and conduct the following public participation activities. If the HEER Office determines that public participation activities are in the public interest or significant concern has been expressed or is likely to be expressed by affected or potentially affected public or private interests, including local communities, as a result of the implementation or outcome of removal action activities, the responsible parties shall conduct the following public participation activities.

1. Publish a notice of availability of the administrative record file in a newspaper.
 - The newspaper must be of general circulation in the state, and if appropriate, as determined by the HEER Office, in a newspaper which is published at least twice weekly in the county affected by the removal action.
 - The notice shall be published within 60 days of initiation of the on-site removal activity.
 - The notice should include the proper site name and location.
2. Provide for a public comment period of not less than 30 days from the time the

administrative record file is made available for public inspection.

- In the above mentioned notice indicate that the HEER Office is soliciting public comment on the planned or ongoing removal action and the date for the public comment period.

8.6.2 Public Participation in Remedial Actions

This second section discusses public participation activities for remedial actions. For remedial actions the HEER Office shall prepare for public comment a draft response action memorandum (RAM). The purpose of the RAM is to document and make available for public comment the HEER Office's preliminary remedy selection decision. The draft RAM shall summarize the site conditions discovered, the problems posed by the release or threat of release, the remedial alternatives analyzed by the HEER Office or other party, a preferred remedial action alternative and the technical aspects of the selected remedy. For remedial actions the HEER Office shall conduct or require to be conducted if appropriate the following public participation activities:

Public Notice of Availability

After the draft RAM is prepared the HEER Office will, or will require another party to:

1. Include copies of the draft RAM and supporting analysis in the administrative record for public inspection prior to the commencement of any remedial action.
2. Publish a notice of availability of the draft RAM in a newspaper. The newspaper must be published at least twice weekly in the county affected by the proposed remedial action, and if appropriate in a newspaper of general circulation in the state. The newspaper notification should include a brief abstract of the draft RAM, which describes the alternatives analyzed and identifies the preferred remedial action.
3. The newspaper notification should consist of the following elements:
 - Site Name and Location. The notice should include the proper site name and location.
 - Identification of the Lead Party. The notice should identify which entities

have served as lead for the proposed remedial action.

Public Comment Period

The HEER Office shall provide or require to be provided if appropriate a public comment period of not less than 30 calendar days for the submission of written and oral comments on the draft RAM and the supporting analysis including the RI.

1. In the above mentioned notice indicate the date for the public comment period. The notice should state that the lead party is soliciting public comment on all of the alternatives evaluated as well as on the preferred remedial action.
2. The notice should inform the public of its role in the remedial action selection process and provide the following information:
 - The location of the administrative record file;
 - The methods by which the public may submit oral and/or written comments

The HEER Office shall upon timely request, and at the discretion of the HEER Office, extend the public comment period. The HEER Office may wish to publish a notice in the newspaper announcing the extension of the public comment period.

Public Meeting

If the HEER Office determines that there is sufficient public interest, then a public meeting should be held. The purpose of the meeting is to discuss and receive citizen feedback on the proposed course of action. The HEER Office may wish to publish a notice in the newspaper announcing the public meeting. The notice must indicate the location, date, time and purpose of the public meeting. The public meeting should be held at or near the affected area.

The HEER Office shall prepare or require to be prepared a transcript, recording or minutes of any public meeting held and make such transcript, recording or minutes available to the public. Copies of the transcript, recording or minutes should be included in the administrative record file.

Addressing Changes in Remedy

The HEER Office has the discretion to make changes to the draft RAM based on new information received from the public or from information generated during the RI or from information generated during the response action process. If after publication of the draft RAM and prior to the selection by the HEER Office of the final response, new information is made available that fundamentally changes the basic features of the remedy with respect to scope, performance, or cost, such that the remedy fundamentally differs from the original proposal in the draft RAM and the supporting analysis and information, the HEER Office shall:

Consider the effect the change has on the scope, performance, or cost of the response action by addressing the following issues and questions:

1. Scope: Changes that alter the selected alternative by addressing a substantially greater or lesser volume of waste, a new environmental pathway, or by encompassing a substantially greater physical area of the site. Does the change significantly alter the scope of the remedy (i.e., the physical area of the response, remediation goals, type and volume of waste)?
2. Performance: Changes in treatment technologies or processes that significantly alter the long-term effectiveness of the remedy or that have significantly different short-term effects. Would the change alter the performance (e.g., treatment levels to be attained) and thus raise concerns about the protectiveness or long-term effectiveness of the remedy that could not have been anticipated based on information in the RAM?
3. Cost: Changes in cost that alter the long-term costs to operate and maintain the equipment and cost of construction. Are the changes in costs of such a nature that they could not have been anticipated based on the estimates in the RAM and the recognized uncertainties associated with the hazardous waste engineering process selected?

Based on this evaluation, the HEER Office will determine whether such change could be reasonably anticipated by the public and shall:

1. Include a discussion in the final RAM of the fundamental changes and reasons for such changes, if the HEER Office determines such changes could be reasonably anticipated by the public based on the alternatives and other information available in the draft RAM or the supporting analysis and information in the administrative record; or

2. Seek additional public comment on a revised draft RAM, when the HEER Office determines the fundamental changes could not have been reasonably anticipated by the public based on the information available in the initial draft RAM or the supporting analysis and information in the administrative record.
 - The HEER Office shall, prior to adoption of the selected remedy in the RAM, issue a revised draft RAM, which shall include a discussion of the fundamental changes and the reasons for such changes, in accordance with the public participation requirements described in this section.

Based upon public comments on the draft RAM, the HEER Office shall reassess whether the initial determination was appropriate, make a final decision on the remedial action, and document the decision in the RAM, for inclusion in the administrative record.

Example of pre-RAM changes

The following text provides examples of the two types of changes that can be made to the selected remedy (i.e., significant changes that should be explained in the RAM, and significant changes that should be explained in both a revised draft RAM and a new public comment period). At a hypothetical site, disposal of septic waste and some hazardous substances has resulted in the contamination of 11,000 cubic yards of soil with volatile organic compounds (VOCs) and metals. There are six alternatives identified in the RI for controlling the source of contamination at the site:

- (1) No capping;
- (2) Capping;
- (3) Excavation and disposal in an off-site landfill;
- (4) Excavation, vaporization of volatile organics, and disposal in an on-site landfill;
- (5) Off-site incineration; and
- (6) On-site incineration and solidification.

The preferred alternative in the draft RAM was the fourth alternative, which specifically

calls for:

- The excavation, vaporization, and disposal in an on-site landfill of 11,000 cubic yards of contaminated soil; and
- Implementation time: 12 to 15 months.

Significant Change Requiring RAM Documentation:

The lead party receives new information during the public comment period that prompts a change in the remediation goal for the soil; as a result, the volume of contaminated soils that should be addressed is increased by 10,000 cubic yards more than the initial estimate. To incorporate this change, the final remedial action plan specifications are modified as follows:

- Excavation, vaporization, and disposal in an on-site landfill of 14,600 cubic yards of contaminated soil;
- Implementation time: 18 to 21 months.

To address the larger volume of contaminated soils, the lead party decides to implement the preferred response action alternative with some changes made to those components presented in the draft RAM. The decision to increase the volume of soils could be considered a logical outgrowth of the information, even though doing so would impact the scope or performance of the response action. The time required to implement the remedy is increased by approximately six months. The changes in the specifications of the components of the response action are documented in the RAM Decision Summary, including an explanation of why the changes were made. No additional public comment period is necessary.

Significant Change Requiring a Revised draft RAM:

A remedy is selected that was NOT presented in the original draft RAM. The selected response action is:

- In-situ vitrification of 11,000 cubic yards of contaminated soil.
- Implementation time: 12 to 15 months.

This response action is selected because new information is received indicating that in-situ vitrification could be used effectively at the site. This new remedy, however, is quite different in scope and performance from any other alternative considered in detail in the draft RAM. Because the public has not had an adequate opportunity to comment on the technical, environmental, and human health aspects of the remedy or to

evaluate and compare its performance in terms of the evaluation criteria, a revised draft RAM should be prepared and a new public comment period should be held before the remedy is adopted in the RAM.

Final RAM

After the RAM is finalized, the HEER Office or other parties shall make the RAM and supporting analysis available for public inspection, prior to the commencement of any response action. Include copies of the finalized RAM and supporting analysis in the administrative record for public inspection.

Section 9

ISSUES RELATED TO CONTAMINATION FROM OIL



Section 9

ISSUES RELATED TO CONTAMINATION FROM OIL

9.1 Introduction

The purpose of this section is to provide specific guidance to sites which are contaminated with oil. In the state of Hawaii, we believe that the majority of the sites to be addressed by Chapter 128-D and the State Contingency Plan (SCP) will be related to petroleum contamination. This guidance is to supplement the information provided in other sections of the TGM and is intended only to provide clarification for commonly encountered situations.

This section is to be used for sites with TPH contamination only (all other constituents must be below Tier 1 action levels, or established background values). Sites which also contain other contaminants in association with the TPH (i.e., BTEX, PAHs) must meet requirements and follow the procedures discussed in previous sections of this TGM.

9.2 Definition

Oil is defined as crude oil and any fraction or residue thereof, in any form, including, but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes. Oil is designated as a hazardous substance in Chapter 128-D, Hawaii Environmental Response Law (HERL).

9.3 Notification Requirements

Notification of a release must be provided by "the person in charge of a facility or vessel." This is typically the facility operator or the land owner.

For oil, the reportable quantity is defined as:

1. Any amount of oil which when released into the environment causes a sheen to appear on surface water, or any navigable water of the state;
2. Any free product that appears on ground water;

3. Any amount of oil released to the environment greater than 25 gallons; and
4. Any amount of oil (i.e., 25 gallons or less) released to the environment which is not contained and remedied within 72 hours.

As an example, assume that a crack in a gasoline storage tank is not found until after 1,000 gallons have leaked into an earthened bermed area. This is a reportable release to the environment.

Containment is defined as a system which is designed, constructed and maintained appropriately for the material and the quantity of material stored, and completely contains the material released. A paved parking lot does not meet these requirements. A fully lined, concrete, secondary-containment system around an above ground tank, pipeline or other piece of equipment may meet these requirements. In determining whether a particular surface, structure or stratum meets contaminants requirements and is part of the "environment" as defined in the rules, parties who have responsibility to report releases should evaluate whether the surface, structure or stratum is designed, constructed, and maintained to enable it to contain the discharged hazardous substance.

As a second example, assume construction repair work is being performed and the backhoe driver encounters an area of petroleum contaminated soil. This should be reported by the person in charge of the facility because it is not contained and the contaminated soil is considered to be the source of the ongoing release of a hazardous substance to the environment.

9.4 Investigation Approach

Petroleum released to the environment may remain on the land surface, volatilize into the atmosphere, and/or soak into the ground and entering the subsurface. If released into a body of water, a small amount of the oil will dissolve into the water and the remainder will create a sheen or pool on the surface of the water. Once the contaminant enters the subsurface, it partitions in four phases: a vapor phase, a free phase (liquid), an adsorbed phase, and a dissolved phase. Petroleum contaminants that have a specific gravity less than water are considered Light Non-Aqueous Phase Liquids, or LNAPLs.

Oil products are complex mixtures of hundreds of chemicals many of which are toxic. Once a petroleum product is released to the environment, changes in composition occur as a result of weathering. These compositional changes may result in changes in the toxicity of the contamination as a whole. Weathering involves a number of processes including volatilization, hydrolysis, photolysis, biodegradation, biotransformation, physical breakup and dissolution.

Investigation of petroleum releases should follow the same process outlined in Section 4, Field Investigation, of this TGM. A SAP, QAPP, and Work Plan (including the development of DQO's) should be developed and a field investigation which relies on data collected in the field and confirmed in the laboratory should be conducted. Acceptable laboratory analysis methods include the following (data analyzed with equivalent methods will also be accepted):

Immunoassay methods :

1. TPH (EPA 4030)
2. BTEX (EPA 4031)
3. PAH (EPA 4035)
4. BTEX (EPA 8020)
5. PAHs (EPA 8100 or 8270)
6. PCBs (EPA 8080)
7. Phenols (EPA 8040 or 8720)
8. Diesel, gasoline (EPA 8170, 8270, 8015, LUFT Method)
9. Total Metals (EPA 6010 & 7000 series)

When toxic constituents such as BTEX, PAHs and/or Lead are encountered at levels which potentially pose a threat to public health or the environment, then the response action will most likely center on the clean up of the environment to reduce these contaminants of concern. The risk assessment process, as described in Section 5, will most likely need to be employed in order to determine appropriate clean up values. Remediation of contaminated soil and/or groundwater with respect to the TPH will most likely be a secondary goal of the response action. Therefore, when toxic compounds are encountered while investigating a petroleum release, the previous sections of the this TGM should be referred to for guidance.

If the release is a recent release, then the site should be screened for the identification of grossly contaminated soil. The procedures for this screening are provided in Appendix 9A of this Section.

If TPH above a detectable level has been encountered and has been determined to be the primary contaminant of concern and is likely to lead to contamination off the owner's property, the extent of contamination, both vertically and horizontally, should be determined to the property boundary. The plume should be presented in a mapped format.

Additional information on the site description, regional geology and hydrology must be provided as part of the response action documentation. All of the information should be provided on maps and cross sections. Refer to other sections of the TGM for this information.

9.5 Response Action Levels

Petroleum impacted soil (greater than 2 feet below ground surface) that meets clean up levels for all other toxic constituents (i.e., BTEX, Lead, PAHs, etc.) can be left in place at the release site provided that:

- The extent of the impact is defined,
- The impacted soil does not create nuisance problems (odor),
- The facility ensures that residual petroleum does not migrate offsite (i.e., via groundwater) and negatively impact adjacent properties, nearby groundwater extraction wells, or surface water bodies, and
- The following TPH values are not exceeded:

| | |
|---------------------|-------------|
| TPH - oil or diesel | 5,000 mg/kg |
| TPH - gasoline | 2,000 mg/kg |

The facility should take any steps necessary to ensure that residual petroleum left in place at a site will not migrate offsite and impact adjacent properties, groundwater extraction wells, or surface waters. This will generally involve response action to remove the most heavily impacted soil at the site.

Petroleum impacted surface soils (upper 2 feet) must be appropriately remediated to meet nuisance concerns. Free product located at the groundwater interface must be removed to the extent practicable. Groundwater should be remediated to meet appropriate criteria for constituent specific contaminants.

9.6 Disposal of Petroleum Contaminated Soils

The offsite reuse and disposal of petroleum impact soil that is excavated from a site is regulated under guidelines from the DOH Office of Solid Waste Management (OSWM). The OSWM classifies soils as Class I or Class II. Disposal options are based on which classification is found.

Soils above a drinking water aquifer are at levels at or below the following:

| | |
|---------------|----------|
| Benzene | 0.05 ppm |
| Ethyl benzene | 0.50 ppm |
| Toluene | 16.0 ppm |

| | |
|------------------------------|-----------------------|
| Lead ¹ (total) | 400 ppm or background |
| Cadmium ² (total) | 2.0 ppm or background |
| TPH - oil | 60 ppm |
| TPH - diesel | 25 ppm |
| TPH - gasoline | 5 ppm |

Use of the soils which meet these levels is not restricted.

Soils above non-drinking water aquifer are at or below the following:

| | |
|----------------|----------|
| Benzene | 1.7 ppm |
| Ethyl benzene | 0.50 ppm |
| Toluene | 34.0 ppm |
| TPH - oil | 200 ppm |
| TPH - diesel | 200 ppm |
| TPH - gasoline | 100 ppm |

These soils can be disposed of by backfill at a site after treatment, fill in a commercial or industrial area, cover in permitted landfills, road subgrade or other road construction fill. Use near wetlands, areas of shallow groundwater, surface water bodies, near drinking water extraction wells, or use as topsoil in residential areas is **NOT** recommended.

These numbers are established by policy from the DOH OSWM and may be changed as needed.

9.7 Petroleum-Impacted Soils Encountered During Construction Projects

Note: Notification by the property owner or operator is still required when petroleum is encountered during construction. Following these guidelines does not absolve the property owner of liability for the contamination. The owner/operator must weigh the benefit of completing the project versus conducting the removal/remedial action to deal with the petroleum contamination at the time of notification.

Petroleum-impacted soils are commonly found during the course of excavation in the

¹Soils with lead contamination above 400 ppm or must be reviewed for remediation and addressed appropriately.

²Soils with cadmium contamination above 2.0 ppm must reviewed for remediation and addressed as appropriate.

state of Hawaii. The company performing the excavation should be aware of the potential impact on the health and safety of the workers that the contamination may present. Facilities that encounter petroleum-impacted soils during construction projects should follow these guidelines:

1. Before initiation of the project, the construction company should conduct a public records search of pertinent information on sources or potential sources of petroleum contamination in the vicinity of the projects.
2. If contamination is suspected at a site, soil and water that is encountered should be sampled and tested for contaminants. A sampling plan and the sample results must be submitted to HEER Office.
3. If contaminants are found, the person in charge of the facility (owner or operator of the property) should officially notify the HEER Office of the release. The HEER Office will then determine if additional investigation is needed.
4. Upon discovery of petroleum contamination, a determination needs to be made as to the flammability of the petroleum contaminant. If the petroleum contaminant poses and endangerment to public health or the environment or the onsite workers or nearby public due to the flammability/explosive potential, then the appropriate measures must be taken on an emergency response plan until the site is deemed to be safe.
5. If floating petroleum products are encountered, as much of the petroleum as possible should be recovered for reuse or disposal.
6. Contaminated soil to be removed from the area must be treated, stored or disposed of in accordance with all applicable State and Federal requirements. Generally, contaminated soils should not be redeposited into any excavated area unless otherwise approved by DOH. The excavations should be backfilled only with clean soils unless it can be demonstrated that clean soils will be recontaminate. In that scenario, the area where contamination of the fill would occur could be temporarily backfilled with the contaminated material which was originally excavated. Clean material should be placed on top of the contaminated fill in order to ensure that no contaminated material are exposed at the surface.
7. If the activity undertaken requires dewatering, any contaminated groundwater pumped out must be treated, stored or disposed of in accordance with all applicable state and federal requirements. Oil/water separation may be considered the minimum effort to be taken.

8. Appropriate air monitoring should be initiated according to the site specific health and safety plan.
9. Detailed records should be maintained of all investigative and clean up activities conducted. Copies of these reports should be submitted to the HEER Office.

9.8 Applicable Technologies

Section 5 of this TGM provides additional details on applicable remedial alternatives for soils and groundwater impacted with petroleum products. As an overview, the following remedial technologies have been shown to provide some remediation of soils and/or groundwater contamination. Other technologies should also be evaluated. When employing some of these technologies, air emission controls may also be required.

- Recovery of Free Product
- Groundwater Pump and Treat
- Excavation of Soils
- Capping
- Soil Vapor Extraction
- Air Sparging
- Bioremediation
- Natural Attenuation
- Aeration

Section 5 of this TGM also provides additional information on the response action process (Removal and Remedial) which must be followed when determining an appropriate response action and the applicability of a specific technology.

Section 9

Appendix 9A

Field Measurement Procedures for the Identification of Grossly Contaminated Soil in the Unsaturated Zone

Appendix 9A

FIELD MEASUREMENT PROCEDURES FOR THE IDENTIFICATION OF GROSSLY CONTAMINATED SOIL IN THE UNSATURATED ZONE

DOH recommends that the following procedures be used during release response activities in order to determine gross contamination in soils due to releases of oil. These procedures include two ways to determine gross contamination, depending on the types of product which have been released: (1) by organic vapor measurements for gasoline and diesel range petroleum products, and (2) by visual or olfactory evidence for heavy oils.

The measurement methods and gross contamination criteria for gasoline range petroleum products, diesel range petroleum products, and heavy oils are provided below. For guidance on the number and locations of samples for assessing residual contamination, follow the guidance provided in Section 4 and Section 9 of this TGM.

Note: Other field measurement methods can also be used in lieu of the procedures presented in this appendix, as appropriate.

Measurement Methods and Gross Contamination Criteria

Note: Owners and operators should use the measurement methods and gross contamination criteria for gasoline range petroleum products only for releases of fresh gasoline range petroleum products. When measuring contamination caused by releases of weathered gasoline, releases of mixed petroleum products, or releases of undetermined origin, owners and operators should use the measurement methods and gross contamination criteria for diesel range petroleum products and/or heavy oils, as applicable.

A. Gasoline Range Petroleum Products

Gasoline range petroleum products are those with an alkane range of C_6 to C_{10} and a boiling point range of between approximately 60°C and 170°C. This category includes gasoline, aviation gasoline, and other volatile petroleum products.

Soil contaminated with gasoline range petroleum products may be screened for gross contamination using an organic vapor analyzer (OVA) fitted with a flame ionization detector in the survey mode. (Photoionization detectors may be used when calibrated accordingly.) Each soil sample should be placed half-filled in a 16 ounce soil jar, covered, brought to a temperature of between 20°C and 32°C, and allowed to

equilibrate for 5 minutes. At that time, the organic vapor content of the headspace of the jar should be measured by puncturing the cover with the OVA probe. **The soil is considered to be grossly contaminated if organic vapor measurements taken in this manner exceed 500 ppm.**

B. Diesel Range Petroleum Products

Diesel range petroleum products are those with an alkane range of C_{10} to C_{28} and a boiling point range of between approximately 170°C and 430°C. This category includes diesel fuel, jet fuel (JP-4, Jet A, etc.), kerosene, light fuel oils, and other middle distillate petroleum products. Contamination caused by older, weathered releases of gasoline range petroleum products is also included in this range since it resembles diesel range petroleum product contamination because of the loss of much of the volatile constituents over time.

Soil contaminated with diesel range petroleum products may be screened for gross contamination using the same method as for gasoline range petroleum products. **However, for diesel range petroleum products, the soil is considered to be grossly contaminated if organic vapor measurements taken in this manner exceed 50 ppm.**

In addition, at least one representative soil sample must be procured and analyzed in the laboratory to substantiate remaining soil contamination conditions. EPA methods 3550/8015, or equivalent may be used for this analysis.

C. Heavy Oils

Heavy oils are those petroleum products with an alkane range greater than C_{28} and a boiling point range greater than approximately 430°C. This category includes motor oil, waste oil, used oil, hydraulic oil, heavy oils (No. 5 and No. 6 fuel oil, Bunker C fuel, etc.), crude oils, and other heavy petroleum products.

Soil contaminated with heavy oils may be screened for gross contamination using visual and olfactory cues. **The soil is considered to be grossly contaminated if any visible staining or noticeable odors are present.**

In addition, at least one representative soil sample must be procured and analyzed in the laboratory to substantiate remaining soil contamination conditions. EPA method 3550/5520 C or F may be used for this analysis.

Rationale for Selection of Determinants for Gross Contamination

The 500 ppm organic vapor criterion for gasoline range petroleum products was selected as a clear indication of petroleum contamination. (As a secondary consideration, 500 ppm falls in the middle of the detection range of a flame ionization

detector and therefore will produce more accurate readings.) The 50 ppm organic vapor criterion for diesel range petroleum products was selected due to the relatively smaller percentage of volatiles present in this category of petroleum products. Finally, visual and olfactory criteria were selected for heavy oils since this category of petroleum products contains minimal volatiles.